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THE COLORS OF ANIMALS AND PLANTS.[1]

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I. THE COLORS OF ANIMALS.

THERE is probably no one quality of natural objects from which we derive so much pure and intellectual enjoyment as from their colors. The "heavenly" blue of the firmament, the glowing tints of sunset, the exquisite purity of the snowy mountains, and the endless shades of green presented by the verdure-clad surface of the earth, are a never-failing source of pleasure to all who enjoy the inestimable gift of sight. Yet these constitute, as it were, but the frame and background of a marvelous and ever-changing picture. In contrast with these broad and soothing tints, we have presented to us, in the vegetable and animal worlds, an infinite variety of objects adorned with the most beautiful and most varied hues. Flowers, insects, and birds are the organisms most generally ornamented in this way; and their symmetry of form, their variety of structure, and the lavish abundance with which they clothe and enliven the earth cause them to be objects of universal admiration. The relation of this wealth of color to our mental and moral nature is indisputable. The child and the savage alike admire the gay tints of flower, bird, and insect; while to many of us their contemplation brings a solace and enjoyment which is both intellectually and morally beneficial. It can then hardly excite surprise that this relation was long thought to afford a sufficient explanation of the phenomena of color in nature, and although the fact that

> "Full many a flower is born to blush unseen,
> And waste its sweetness on the desert air"

might seem to throw some doubt on the sufficiency of the explanation, the answer was easy: that, in the progress of discovery,

[1] From Macmillan's Magazine.

man would, sooner or later, find out and enjoy every beauty that the hidden recesses of the earth have in store for him. This theory received great support from the difficulty of conceiving any other use or meaning in the colors with which so many natural objects are adorned. Why should the homely gorse be clothed in golden raiment, and the prickly cactus be adorned with crimson bells? Why should our fields be gay with buttercups, and the heather-clad mountains be clad in purple robes? Why should every land produce its own peculiar floral gems, and the Alpine rocks glow with beauty, if not for the contemplation and enjoyment of man? What could be the use to the butterfly of its gayly-painted wings, or to the humming-bird of its jeweled breast, except to add the final touches to a world picture, calculated at once to please and to refine mankind? And even now, with all our recently acquired knowledge of this subject, who shall say that these old-world views were not intrinsically and fundamentally sound, and that although we now know that color has "uses" in nature that we little dreamed of, yet the relation of those colors to our senses and emotions may be another and perhaps more important use which they subserve in the great system of the universe?

We now propose to lay before our readers a general account of the more recent discoveries on this interesting subject, and, in doing so, it will be necessary, first, to give an outline of the more important facts as to the colors of organized beings; then, to point out the cases in which it has been shown that color is of use; and, lastly, to endeavor to throw some light on its nature and the general laws of its development.

Among naturalists color was long thought to be of little import, and to be quite untrustworthy as a specific character. The numerous cases of variability of color led to this view. The occurrence of white blackbirds, white peacocks, and black leopards, of white bluebells, and of white, blue, or pink milkworts led to the belief that color was essentially unstable; that it could therefore be of little or no importance, and belonged to quite a different class of characters from form or structure. But it now begins to be perceived that these cases, though tolerably numerous, are, after all, exceptional, and that color, as a rule, is a constant character. The great majority of species, both of animals and plants, are each distinguished by peculiar tints which vary very little, while the minutest markings are often constant in thousands or millions of individuals. All our field buttercups are

invariably yellow, and our poppies red, while many of our butterflies and birds resemble each other in every spot and streak of color through thousands of individuals. We also find that color is constant in whole genera and other groups of species. The Genistas are all yellow, the Erythrinas all red; many genera of Carabidæ are entirely black; whole families of birds — as the Dendrocolaptidæ — are brown; while among butterflies the numerous species of Lycæna are all more or less blue, those of Pontia white, and those of Callidryas yellow. An extensive survey of the organic world thus leads us to the conclusion that color is by no means so unimportant or inconstant a character as at first sight it appears to be; and the more we examine it the more convinced we shall become that it must serve some purpose in nature, and that besides charming us by its diversity and beauty it must be well worthy of our attentive study, and have many secrets to unfold to us.

In order to group the great variety of facts relating to the colors of the organic world in some intelligible way, it will be best to consider how far the chief theories already proposed will account for them. One of the most obvious and most popular of these theories, and one which is still held, in part at least, by many eminent naturalists, is that color is due to some direct action of the heat and light of the sun, thus at once accounting for the great number of brilliant birds, insects, and flowers which are found between the tropics. But here we must ask whether it is really the fact that color is more developed in tropical than in temperate climates in proportion to the whole number of species; and, even if we find this to be so, we have to inquire whether there are not so many and such striking exceptions to the rule as to indicate some other causes at work than the direct influence of solar light and heat. As this is a most important question we must go into it somewhat fully.

It is undoubtedly the case that there are an immensely greater number of richly-colored birds and insects in tropical than in temperate and cold countries; but it is by no means so certain that the *proportion* of colored to obscure species is much or any greater. Naturalists and collectors well know that the majority of tropical birds are dull colored; and there are whole families, comprising hundreds of species, not one of which exhibits a particle of bright color. Such are the Timaliidæ of the eastern and the Dendrocolaptidæ of the western hemisphere. Again, many groups of birds, which are universally distributed, are no more

adorned with color in the tropical than in the temperate zone: such are thrushes, wrens, goat-suckers, hawks, grouse, plovers, and snipe; and if tropical light and heat have any direct coloring effect, it is certainly most extraordinary that in groups so varied in form, structure, and habits as those just mentioned the tropical should be in no wise distinguished in this respect from the temperate species. The brilliant tropical birds mostly belong to groups which are wholly or almost wholly tropical, as the chatterers, toucans, trogons, and pittas; but as there are, perhaps, an equal number of groups which are wholly dull colored, while others contain dull and bright colored species in nearly equal proportions, the evidence is by no means strong that tropical light or heat has anything to do with the matter. But there are also groups in which the cold and temperate zones produce finer-colored species than the tropics. Thus the arctic ducks and divers are handsomer than those of the tropical zone, while the king duck of temperate America and the mandarin duck of Northern China are the most beautifully colored of the whole family. In the pheasant family we have the gorgeous gold and silver pheasants in Northern China and Mongolia, and the superb impeyan pheasant in the temperate Northwest Himalayas, as against the peacocks and fire-backed pheasants of tropical Asia. Then we have the curious fact that most of the bright-colored birds of the tropics are denizens of the forests, where they are shaded from the direct light of the sun, and that they abound near the equator, where cloudy skies are very prevalent; while, on the other hand, places where light and heat are at a maximum have often dull-colored birds. Such are the Sahara and other deserts, where almost all the living things are sand colored; but the most curious case is that of the Galapagos Islands, situated under the equator and not far from South America, where the most gorgeous colors abound, but which are yet characterized by prevailing dull and sombre tints in birds, insects, and flowers, so that they reminded Mr. Darwin of the cold and barren plains of Patagonia. Insects are wonderfully brilliant in tropical countries generally, and any one looking over a collection of South American or Malayan butterflies would scout the idea of their being no more gayly colored than the average of European species, and in this they would be undoubtedly right. But on examination we should find that all the more brilliantly colored groups were exclusively tropical, and that where a genus has a wide range there is little difference in color-

ation between the species of cold and warm countries. Thus the European Vanessides, including the beautiful "peacock," "Camberwell beauty," and "red admiral" butterflies, are quite up to the average of tropical beauty in the same group, and the remark will equally apply to the little "blues" and "coppers;" while the Alpine "Apollo" butterflies have a delicate beauty that can hardly be surpassed. In other insects, which are less directly dependent on climate and vegetation, we find even greater anomalies. In the immense family of the Carabidæ or predaceous ground-beetles the northern forms fully equal, if they do not surpass, all that the tropics can produce. Everywhere, too, in hot countries, there are thousands of obscure species of insects which, if they were all collected, would not improbably bring down the average of color to much about the same level as that of temperate zones.

But it is when we come to the vegetable world that the greatest misconception on this subject prevails. In abundance and variety of floral color the tropics are almost universally believed to be preëminent, not only absolutely, but relatively to the whole mass of vegetation and the total number of species. Twelve years of observation among the vegetation of the eastern and western tropics has, however, convinced me that this notion is entirely erroneous, and that, in proportion to the whole number of species of plants, those having gayly colored flowers are actually more abundant in the temperate zones than between the tropics. This will be found to be not so extravagant an assertion as it may at first appear if we consider how many of the choicest adornments of our greenhouses and flower shows are really temperate as opposed to tropical plants. The masses of color produced by our rhododendrons, azaleas, and camellias, our pelargoniums, calceolarias, and cinerarias, — all strictly temperate plants, — can certainly not be surpassed, if they can be equaled, by any productions of the tropics.[1] But we may go further, and say that the

[1] It may be objected that most of the plants named are choice, cultivated *varieties*, far surpassing in color the original stock, while the tropical plants are mostly unvaried wild *species*. But this does not really much affect the question at issue. For our florists' gorgeous varieties have all been produced under the influence of our cloudy skies, and with even a still further deficiency of light, owing to the necessity of protecting them under glass from our sudden changes of temperature, so that they are themselves an additional proof that tropical light and heat are not needed for the production of intense and varied color. Another important consideration is that these cultivated *varieties* in many cases displace a number of wild *species* which are hardly, if at all, cultivated. Thus there are scores of *species* of wild hollyhocks varying in color almost as much as the cultivated varieties, and the same may be said of the

hardy plants of our cold temperate zone equal if they do not surpass the productions of the tropics. Let us only remember such gorgeous tribes of flowers as the roses, peonies, hollyhocks, and antirrhinums, the laburnum, Wistaria, and lilac, the lilies, irises, and tulips, the hyacinths, anemones, gentians, and poppies, and even our humble gorse, broom, and heather; and we may defy any tropical country to produce masses of floral color in greater abundance and variety. It may be true that individual tropical shrubs and flowers do surpass everything in the rest of the world, but that is to be expected, because the tropical zone comprises a much greater land area than the two temperate zones, while, owing to its more favorable climate, it produces a still larger proportion of species of plants and a great number of peculiar natural orders.

Direct observation in tropical forests, plains, and mountains fully supports this view. Occasionally we are startled by some gorgeous mass of color, but as a rule we gaze upon an endless expanse of green foliage, only here and there enlivened by not very conspicuous flowers. Even the orchids, whose gorgeous blossoms adorn our stoves, form no exception to this rule. It is only in favored spots that we find them in abundance; the species with small and inconspicuous flowers greatly preponderate, and the flowering season of each kind being of short duration they rarely produce any marked effect of color amid the vast masses of foliage which surround them. An experienced collector in the eastern tropics once told me that although a single mountain in Java had produced three hundred species of Orchideæ only about two per cent. of the whole were sufficiently ornamental or showy to be worth sending home as a commercial speculation. The Alpine meadows and rock slopes, the open plains of the Cape of Good Hope or of Australia, and the flower prairies of North America offer an amount and variety of floral color which can certainly not be surpassed even if it can be equaled between the tropics.

It appears, therefore, that we may dismiss the theory that the development of color in nature is directly dependent on, and in any way proportioned to, the amount of solar heat and light as entirely unsupported by facts. Strange to say, however, there

pentstemons, rhododendrons, and many other flowers; and if these were all brought together in well-grown specimens they would produce a grand effect. But it is far easier and more profitable for our nursery-men to grow *varieties* of one or two species, which all require a very similar culture, rather than fifty distinct *species*, most of which would require special treatment, the result being that the varied beauty of the temperate flora is even now hardly known except to botanists and to a few amateurs.

are some rare and little-known phenomena which prove that, in exceptional cases, light does directly affect the colors of natural objects, and it will be as well to consider these before passing on to other matters.

A few years ago Mr. T. W. Wood called attention to the curious changes in the color of the chrysalis of the small cabbage butterfly (*Pontia rapæ*), when the caterpillars were confined in boxes lined with different tints. Thus in black boxes they were very dark, in white boxes nearly white; and he further showed that similar changes occurred in a state of nature, chrysalises fixed against a whitewashed wall being nearly white, against a red-brick wall reddish, against a pitched paling nearly black. It has also been observed that the cocoon of the emperor moth is either white or brown, according to the surrounding colors. But the most extraordinary example of this kind of change is that furnished by the chrysalis of an African butterfly (*Papilio Nireus*), observed at the Cape by Mrs. Barber, and described (with a colored plate) in the Transactions of the Entomological Society, 1874, page 519. The caterpillar feeds on the orange-tree, and also on a forest tree (*Vepris lanceolata*) which has a lighter green leaf, and its color corresponds with that of the leaves it feeds upon, being of a darker green when it feeds on the orange. The chrysalis is usually found suspended among the leafy twigs of its food-plant or of some neighboring tree, but it is probably often attached to larger branches; and Mrs. Barber has discovered that it has the property of acquiring the color, more or less accurately, of any natural object it may be in contact with. A number of the caterpillars were placed in a case with a glass cover, one side of the case being formed by a red-brick wall, the other sides being of yellowish wood. They were fed on orange leaves, and a branch of the bottle-brush tree (*Banksia*, sp.) was also placed in the case. When fully fed some attached themselves to the orange twigs, others to the bottle-brush branch, and these all changed to green pupæ, but each corresponded exactly in tint to the leaves around it, the one being dark, the other a pale, faded green. Another attached itself to the wood, and the pupa became of the same yellowish color; while one fixed itself just where the wood and brick joined, and became one side red, the other side yellow! These remarkable changes would perhaps not have been credited had it not been for the previous observations of Mr. Wood; but the two support each other, and

oblige us to accept them as actual phenomena. It is a kind of natural photography, the particular colored rays to which the fresh pupa is exposed in its soft, semi-transparent condition effecting such a chemical change in the organic juices as to produce the same tint in the hardened skin. It is interesting, however, to note that the range of color that can be acquired seems to be limited to those of natural objects to which the pupa is likely to be attached; for when Mrs. Barber surrounded one of the caterpillars with a piece of scarlet cloth no change of color at all was produced, the pupa being of the usual green tint, but the small red spots with which it is marked were brighter than usual.

In these caterpillars and pupæ, as well as in the great majority of cases in which a change of color occurs in animals, the action is quite involuntary; but among some of the higher animals the color of the integument can be modified at the will of the animal, or, at all events, by a reflex action dependent on sensation. The most remarkable case of this kind occurs with the chameleon, which has the power of changing its color from dull white to a variety of tints. This singular power has been traced to two layers of pigment deeply seated in the skin, from which minute tubes or capillary vessels rise to the surface. The pigment layers are bluish and yellowish, and by the pressure of suitable muscles these can be forced upward either together or separately. When no pressure is exerted the color is dirty white, which changes to various tints of bluish, green, yellow, or brown, as more or less of either pigment is forced up and rendered visible. The animal is excessively sluggish and defenseless, and its power of changing its color to harmonize with surrounding objects is essential to its existence. Here, too, as with the pupa of *Papilio Nireus*, colors such as scarlet or blue, which do not occur in the immediate environment of the animal, cannot be produced. Somewhat similar changes of color occur in some prawns and flat-fish, according to the color of the bottom on which they rest. This is very striking in the chameleon shrimp (*Mysis chamæleon*), which is gray when on sand, but brown or green when among sea-weed of these two colors. Experiment shows, however, that when blinded the change does not occur, so that here, too, we probably have a voluntary or reflex sense-action. Many cases are known among insects in which the same species has a different tint according to its surroundings, this being particularly marked in some South African locusts which correspond with

the color of the soil wherever they are found, while several caterpillars which feed on two or more plants vary in color accordingly. Several such changes are quoted by Mr. R. Meldola in a paper on Variable Protective Coloring in Insects,[1] and some of them may perhaps be due to a photographic action of the reflected light. In other cases, however, it has been shown that green chlorophyll remains unchanged in the tissues of leaf-eating insects, and being discernible through the transparent integument produces the same color as that of the food plant.

These peculiar powers of change of color and adaptation are, however, rare and quite exceptional. As a rule there is no direct connection between the colors of organisms and the kind of light to which they are usually exposed. This is well seen in most fishes and in such marine animals as porpoises, whose backs are always dark, although this part is exposed to the blue and white light of the sky and clouds, while their bellies are very generally white, although these are constantly subjected to the deep-blue or dusky-green light from the bottom. It is evident, however, that these two tints have been acquired for concealment and protection. Looking *down* on the dark back of a fish it is almost invisible, while to an enemy looking *up* from below, the light under surface would be equally invisible against the light of the clouds and sky. Again, the gorgeous colors of the butterflies which inhabit the depths of tropical forests bear no relation to the kind of light that falls upon them, coming as it does almost wholly from green foliage, dark-brown soil, or blue sky; and the bright under wings of many moths, which are exposed only at night, contrast remarkably with the sombre tints of the upper wings, which are more or less exposed to the various colors of surrounding nature.

We find, then, that neither the general influence of solar light and heat nor the special action of variously-tinted rays are adequate causes for the wonderful variety, intensity, and complexity of the colors that everywhere meet us in the animal and vegetable world. Let us, therefore, take a wider view of these colors, grouping them into classes determined by what we know of their actual uses or special relations to the habits of their possessors. This, which may be termed the functional or biological classification of the colors of living organisms, seems to be best expressed by a division into five groups, as follows: —

[1] Proceedings of the Zoölogical Society of London, 1873, page 153.

Animals.	1. Protective colors.	
	2. Warning colors.	*a.* Of creatures specially protected.
		b. Of defenseless creatures, mimicking *a.*
	3. Sexual colors.	
	4. Typical colors.	
Plants.	5. Attractive colors	

The nature of the first two groups, protective and warning colors, has been so fully detailed and illustrated in my chapter on Mimicry and other Protective Resemblances among Animals [1] that very little need be added here except a few words of general explanation. Protective colors are exceedingly prevalent in nature, comprising those of all the white arctic animals, the sandy-colored desert forms, and the green birds and insects of tropical forests. It also comprises thousands of cases of special resemblance, — of birds to the surroundings of their nests, and especially of insects to the bark, leaves, flowers, or soil, on or amid which they dwell. Mammalia, fishes, and reptiles, as well as mollusca and other marine invertebrates, present similar phenomena; and the more the habits of animals are investigated, the more numerous are found to be the cases in which their colors tend to conceal them, either from their enemies or from the creatures they prey upon. One of the last-observed and most curious of these protective resemblances has been communicated to me by Sir Charles Dilke. He was shown in Java a pink-colored *Mantis*, which, when at rest, exactly resembled a pink orchis flower. The Mantis is a carnivorous insect which lies in wait for its prey, and by its resemblance to a flower the insects it feeds on would be actually attracted toward it. This one is said to feed especially on butterflies, so that it is really a living trap and forms its own bait! All who have observed animals, and especially insects, in their native haunts and attitudes can understand how it is that an insect which in a cabinet looks exceedingly conspicous may yet, when alive, in its peculiar attitude of repose and with its habitual surroundings, be perfectly well concealed. We can hardly ever tell, by the mere inspection of an animal, whether its colors are protective or not. No one would imagine the exquisitely beautiful caterpillar of the emperor moth, which is green with pink, star-like spots, to be protectively colored; yet when feeding on the heather it so harmonizes with the foliage and flowers as to be almost invisible. Every day fresh cases of protective coloring are being discovered even in our own country, and it is becoming more and more evident that the need of protection has played a very important part in determining the actual coloration of animals.

[1] Contributions to the Theory of Natural Selection, page 45.

The second class — the warning colors — are exceedingly interesting, because the object and effect of these is, not to conceal the object, but to make it conspicuous. To these creatures it is *useful* to be seen and recognized, the reason being that they have a means of defense which, if known, will prevent their enemies from attacking them, though it is generally not sufficient to save their lives if they are actually attacked. The best examples of these specially protected creatures consist of two extensive families of butterflies, the Danaidæ and Acræidæ, comprising many hundreds of species inhabiting the tropics of all parts of the world. These insects are generally large, are all conspicuously and often most gorgeously colored, presenting almost every conceivable tint and pattern; they all fly slowly, and they never attempt to conceal themselves; yet no bird, spider, lizard, or monkey (all of which eat other butterflies) ever touches them. The reason simply is that they are not fit to eat, their juices having a powerful odor and taste that is absolutely disgusting to all these animals. Now, we see the reason of their showy colors and slow flight. It is good for them to be seen and recognized, for then they are never molested; but if they did not differ in form and coloring from other butterflies, or if they flew so quickly that their peculiarities could not be easily noticed, they would be captured, and though not eaten would be maimed or killed. As soon as the cause of the peculiarities of these butterflies was recognized, it was seen that the same explanation applied to many other groups of animals. Thus bees and wasps and other stinging insects are showily and distinctively colored; many soft and apparently defenseless beetles, and many gay-colored moths, were found to be as nauseous as the above-named butterflies; other beetles, whose hard and glossy coats of mail render them unpalatable to insect-eating birds, are also sometimes showily colored; and the same rule was found to apply to caterpillars, all the brown and green (or protectively colored species) being greedily eaten by birds, while showy kinds, which never hide themselves, — like those of the magpie, mullein, and burnet moths, — were utterly refused by insectivorous birds, lizards, frogs, and spiders.[1] Some few analogous examples are found among vertebrate animals. I will only mention here a very interesting case not given in my former work. In his delightful book entitled The Naturalist in Nicaragua, Mr. Belt tells us that there is in that country a frog which is very abundant, which hops about in the day-time, which

[1] Contributions to Theory of Natural Selection, page 117.

never hides himself, and which is gorgeously colored with red and blue. Now, frogs are usually green, brown, or earth-colored, feed mostly at night, and are all eaten by snakes and birds. Having full faith in the theory of protective and warning colors, to which he had himself contributed some valuable facts and observations, Mr. Belt felt convinced that this frog must be uneatable. He therefore took one home, and threw it to his ducks and fowls; but all refused to touch it except one young duck, which took the frog in its mouth, but dropped it directly, and went about jerking its head as if trying to get rid of something nasty. Here the uneatableness of the frog was predicted from its colors and habits, and we can have no more convincing proof of the truth of the theory than such previsions.

The universal avoidance by carnivorous animals of all these specially protected groups, which are thus entirely free from the constant persecution suffered by other creatures not so protected, would evidently render it advantageous for any of these latter which were subjected to extreme persecution to be mistaken for the former, and for this purpose it would be necessary that they should have the same colors, form, and habits. Strange to say, wherever there is an extensive group of directly protected forms (division *a* of animals with warning colors) there are sure to be found a few otherwise defenseless creatures which resemble them externally so as to be mistaken for them, and which thus gain protection as it were on false pretenses (division *b* of animals with warning colors). This is what is called "mimicry," and it has already been very fully treated of by Mr. Bates (its discoverer), by myself, by Mr. Trimen, and others. Here it is only necessary to state that the uneatable Danaidæ and Acræidæ are accompanied by a few species of other groups of butterflies (Leptalidæ, Papilios, Diademas, and Moths) which are all really eatable, but which escape attack by their close resemblance to some species of the uneatable groups found in the same locality. In like manner there are a few eatable beetles which exactly resemble species of uneatable groups; and others, which are soft, imitate those which are uneatable through their hardness. For the same reason wasps are imitated by moths, and ants by beetles; and even poisonous snakes are mimicked by harmless snakes, and dangerous hawks by defenseless cuckoos. How these curious imitations have been brought about, and the laws which govern them, have been discussed in the work already referred to.

The third class — sexual colors — comprise all cases in which

the colors of the two sexes differ. This difference is very general, and varies greatly in amount, from a slight divergence of tint up to a radical change of coloration. Differences of this kind are found among all classes of animals in which the sexes are separated, but they are much more frequent in some groups than in others. In mammalia, reptiles, and fishes, they are comparatively rare and not great in amount, whereas among birds they are very frequent and very largely developed. So among insects, they are abundant in butterflies, while they are comparatively uncommon in beetles, wasps, and hemiptera.

The phenomena of sexual variations of color, as well as of color generally, are wonderfully similar in the two analogous yet totally unrelated groups of birds and butterflies; and, as they both offer ample materials, we shall confine our study of the subject chiefly to them. The most common case of difference of color between the sexes is for the male to have the same general hue as the females, but deeper and more intensified, as in many thrushes, finches, and hawks, and among butterflies in the majority of our British species. In cases where the male is smaller the intensification of color is especially well pronounced, as in many of the hawks and falcons, and in most butterflies and moths in which the coloration does not materially differ. In another extensive series we have spots or patches of vivid color in the male which are represented in the female by far less brilliant tints, or are altogether wanting, as exemplified in the gold-crest warbler, the green woodpecker, and most of the orange-tip butterflies (*Anthocharis*). Proceeding with our survey we find greater and greater differences of color in the sexes, till we arrive at such extreme cases as some of the pheasants, the chatterers, tanagers, and birds-of-paradise, in which the male is adorned with the most gorgeous and vivid colors, while the female is usually dull brown or olive-green, and often shows no approximation whatever to the varied tints of her partner. Similar phenomena occur among butterflies; and in both these classes there are also a considerable number of cases in which both sexes are highly colored in a different way. Thus many woodpeckers have the head in the male red, in the female yellow; while some parrots have red spots in the male, replaced by blue in the female, as in *Psittacula diopthalma*. In many South American papilios green spots on the male are represented by red on the female; and in several species of the genus *Epicalia* orange bands in the male are replaced by blue in the female, a similar change of color as in the

small parrot above referred to. For fuller details of the varieties of sexual coloration we refer our readers to Mr. Darwin's Descent of Man, chapters x. to xviii., and to chapters iii., iv., and vii., of my Contributions to the Theory of Natural Selection.

The fourth group — of typically-colored animals — includes all species which are brilliantly or conspicuously colored in both sexes, and for whose particular colors we can assign no function or use. It comprises an immense number of showy birds, such as kingfishers, barbets, toucans, lories, tits, and starlings ; among insects most of the largest and handsomest butterflies, innumerable bright-colored beetles, locusts, dragon-flies, and hymenoptera ; a few mammalia, as the zebras ; a great number of marine fishes ; thousands of striped and spotted caterpillars ; and abundance of mollusca, star-fish, and other marine animals. Among these we have included some which, like the gaudy caterpillars, have warning colors ; but as that theory does not explain the particular colors or the varied patterns with which they are adorned, it is best to include them also in this class. It is a suggestive fact that all the brightly colored birds mentioned above build in holes or form covered nests, so that the females do not need that protection during the breeding season, which I believe to be one of the chief causes of the dull color of female birds when their partners are gayly colored. This subject is fully argued in my Contributions, etc., chapter vii.

As the colors of plants and flowers are very different from those of animals, both in their distribution and functions, it will be well to treat them separately : we will therefore now consider how the general facts of color here sketched out can be explained. We have first to inquire what is color, and how it is produced ; what is known of the causes of change of color ; and what theory best accords with the whole assemblage of facts.

The sensation of color is caused by vibrations or undulations of the ethereal medium of different lengths and velocities. The whole body of vibrations caused by the sun is termed radiation, and consists of sets of waves which vary considerably in their dimensions and their rate of vibration, but of which the middle portion only is capable of exciting in us sensations of light and color. Beginning with the largest and slowest rays or wave vibrations, we have first those which produce heat sensations only ; as they get smaller and quicker, we perceive a dull-red color ; and as the waves increase in rapidity of vibration and diminish in size, we get successively sensations of orange, yellow, green,

blue, indigo, and violet, all fading imperceptibly into each other. Then come more invisible rays, of shorter wave-length and quicker vibration, which produce, solely or chiefly, chemical effects. The red rays, which first become visible, have been ascertained to vibrate at the rate of four hundred and fifty-eight millions of millions of times in a second, the length of each wave being $\frac{1}{36900}$ of an inch; while the violet rays, which last remain visible, vibrate seven hundred and twenty-seven millions of millions of times per second, and have a wave-length of $\frac{1}{64516}$ of an inch. Although the waves vibrate at different rates, they are all propagated through the ether with the same velocity (192,000 miles per second), just as different musical sounds, which are produced by waves of *air* of different lengths and rates of vibration, travel at the same rate, so that a tune played several hundred yards off reaches the ear in correct time. There are, therefore, an almost infinite number of different color-producing vibrations, and these may be combined in an almost infinite variety of ways, so as to excite in us the sensation of all the varied colors and tints we are capable of perceiving. When all the different kinds of rays reach us in the proportion in which they exist in the light of the sun, they produce the sensation of white. If the rays which excite the sensation of any one color are prevented from reaching us, the remaining rays in combination produce a sensation of color often very far removed from white. Thus green rays being abstracted leave purple light; blue, orange-red light; violet, yellowish-green light; and so on. These pairs are termed complementary colors. And if portions of differently colored lights are abstracted in various degrees, we have produced all those infinite gradations of colors, and all those varied tints and hues, which are of such use to us in distinguishing external objects, and which form one of the great charms of our existence. Primary colors would therefore be as numerous as the different wave-lengths of the visible radiations, if we could appreciate all their differences; while secondary or compound colors, caused by the simultaneous action of any combination of rays of different wave-lengths, must be still more numerous. In order to account for the fact that all colors appear to us capable of being produced by combinations of three primary colors, — red, green, and violet, — it is believed that we have three sets of nerve fibres in the rétina, each of which is capable of being excited by all rays, but that one set is excited most by the larger or red waves, another by the medium or green waves,

and the third set chiefly by the violet or small waves of light; and when all three sets are excited together in proper proportions we see white. This view is supported by the phenomena of color-blindness, which are explicable on the theory that one of these sets of nerve fibres (usually that adapted to perceive red) has lost its sensibility, causing all colors to appear as if the red rays were abstracted from them. It is another property of these various radiations that they are unequally refracted or bent in passing obliquely through transparent bodies, the longer waves being least refracted, the shorter most. Hence it becomes possible to analyze white or any other light into its component rays: a small ray of sunlight, for example, which would produce a round white spot on a wall, if passed through a prism is lengthened out into a band of colored light exactly corresponding to the colors of the rainbow. Any one color can thus be isolated and separately examined, and by means of reflecting mirrors the separate colors can be again compounded in various ways, and the resulting colors observed. This band of colored light is called a *spectrum*, and the instrument by which the *spectra* of various kinds of light are examined is called a *spectroscope*. This branch of the subject has, however, no direct bearing on the mode in which the colors of living things are produced, and it has only been alluded to in order to complete our sketch of the nature of color.

The colors which we perceive in material substances are produced either by the absorption or by the interference of some of the rays which form white light. Pigmental or absorption colors are the most frequent, comprising all the opaque tints of flowers and insects, and all the colors of dyes and pigments. They are caused by rays of certain wave-lengths being absorbed, while the remaining rays are reflected and give rise to the sensation of color. When all the color-producing rays are reflected in due proportion the color of the object is white; when all are absorbed the color is black. If blue rays only are absorbed the resulting color is orange-red; and generally, whatever color an object appears to us, it is because the complementary colors are absorbed by it. The reason why rays of only certain refrangibilities are reflected, and the rest of the incident light absorbed by each substance, is supposed to depend upon the molecular structure of the body. Chemical action almost always implies change of molecular structure; hence chemical action is the most potent cause of change of color. Sometimes simple solution in water effects a marvelous change, as in the case of the well-known aniline dyes, —

the magenta and violet dyes exhibiting, when in the solid form, various shades of golden or bronzy metallic green. Heat, again, often produces change of color, and this without effecting any chemical change. Mr. Ackroyd has recently investigated this subject,[1] and has shown that a large number of bodies are changed by heat, returning to their normal color when cooled, and that this change is almost always in the direction of the less refrangible rays or longer wave-lengths; and he connects the change with molecular expansion caused by heat. As examples may be mentioned mercuric oxide, which is orange-yellow, but which changes to orange, red, and brown, when heated; chromic oxide, which is green, and changes to yellow; cinnabar, which is scarlet, and changes to puce; and metaborate of copper, which is blue, and changes to green and greenish-yellow. The coloring matters of animals are very varied. Copper has been found in the red of the wing of the turaco, and Mr. Sorby has detected no less than seven distinct coloring matters in birds' eggs, several of which are chemically related to those of blood and bile. The same colors are often produced by quite different substances in different groups, as shown by the red of the wings of the burnet moth changing to yellow with muriatic acid, while the red of the red-admiral butterfly undergoes no such change.

These pigmental colors have a different character in animals, according to their position in the integument. Following Dr. Hagen's classification, epidermal colors are those which exist in the external chitinized skin of insects, in the hairs of mammals, and, partially, in the feathers of birds. They are often very deep and rich, and do not fade after death. The hypodermal colors are those which are situated in the inferior soft layer of the skin. These are often of lighter and more vivid tints, and usually fade after death. Many of the reds and yellows of butterflies and birds belong to this class, as well as the intensely vivid hues of the naked skin about the heads of many birds. These colors sometimes exude through the pores, forming an evanescent bloom on the surface.

Interference colors are less frequent in the organic world. They are caused in two ways: either by reflection from the two surfaces of transparent films, as seen in the soap-bubble and in thin films of oil on water; or by fine striæ, which produce colors either by reflected or transmitted light, as seen in mother-of-pearl and in finely-ruled metallic surfaces. In both cases color is produced

[1] Metachromatism, or Color-Change, Chemical News, August, 1876.

by light of one wave-length being neutralized, owing to one set of such waves being caused to be half a wave-length behind the other set, as may be found explained in any treatise on physical optics. The result is that the complementary color of that neutralized is seen; and, as the thickness of the film or the fineness of the striæ undergoes slight changes, almost any color can be produced. This is believed to be the origin of many of the glossy or metallic tints of insects, as well as of those of the feathers of some birds. The iridescent colors of the wings of dragon-flies are caused by the superposition of two or more transparent lamellæ; while the shining blue of the purple-emperor and other butterflies and the intensely metallic colors of humming-birds are probably due to fine striæ.

This outline sketch of the nature of color in the animal world, however imperfect, will at least serve to show us how numerous and varied are the causes which perpetually tend to the production of color in animal tissues. If we consider that, in order to produce white, all the rays which fall upon an object must be reflected in the same proportions as they exist in solar light, whereas, if rays of any one or more kinds are absorbed or neutralized, the resultant reflected light will be colored, and that this color may be infinitely varied according to the proportions in which different rays are reflected or absorbed, we should expect that white would be, as it really is, comparatively rare and exceptional in nature. The same observation will apply to black, which arises from the absorption of all the different rays. Many of the complex substances which exist in animals and plants are subject to changes of color under the influence of light, heat, or chemical change, and we know that chemical changes are continually occurring during the physiological processes of development and growth. We also find that every external character is subject to minute changes, which are generally perceptible to us in closely allied species; and we can therefore have no doubt that the extension and thickness of the transparent lamellæ, and the fineness of the striæ or rugosities of the integuments, must be undergoing constant minute changes; and these changes will very frequently produce changes of color. These considerations render it probable that color is a normal and even necessary result of the complex structure of animals and plants, and that those parts of an organism which are undergoing continual development and adaptation to new conditions, and are also continually subject to the action of light and heat, will be the parts in which changes of

color will most frequently appear. Now, there is little doubt that the external changes of animals and plants in adaptation to the environment are much more numerous than the internal changes, as seen in the varied character of the integuments and appendages of animals (hair, horns, scales, feathers, etc.) and in plants (the leaves, bark, flowers, and fruit), with their various appendages, compared with the comparative uniformity of the texture and composition of their internal tissues; and this accords with the uniformity of the tints of blood, muscle, nerve, and bone, throughout extensive groups, as compared with the great diversity of color of their external organs. It seems a fair conclusion that color *per se* may be considered to be normal, and to need no special accounting for, while the absence of color (that is, either *white* or *black*), or the prevalence of certain colors to the constant exclusion of others, must be traced, like other modifications in the economy of living things, to the needs of the species. Or, looking at it in another aspect, we may say that amid the constant variations of animals and plants color is ever tending to vary and to appear where it is absent, and that natural selection is constantly eliminating such tints as are injurious to the species, or preserving and intensifying such as are useful.

This view is in accordance with the well-known fact of colors which rarely or never appear in the species in a state of nature, continually occurring among domesticated animals and cultivated plants, showing us that the capacity to develop color is ever present, so that almost any required tint can be produced which may, under changed conditions, be useful, in however small a degree.

Let us now see how these principles will enable us to understand and explain the varied phenomena of color in nature, taking them in the order of our functional classification of colors (page 650).

Theory of Protective Colors.—We have seen that obscure or protective tints in their infinitely varied degrees are present in every part of the animal kingdom, whole families or genera being often thus colored. Now, the various brown, earthy, ashy, and other neutral tints are those which would be most readily produced, because they are due to an irregular mixture of many kinds of rays; while pure tints require either rays of one kind only, or definite mixtures in proper proportions of two or more kinds of rays. This is well exemplified by the comparative difficulty of producing definite pure tints by the mixture of two or

more pigments, while a hap-hazard mixture of a number of these will be almost sure to produce browns, olives, or other neutral or dirty colors. An indefinite or irregular absorption of some rays and reflection of others would, therefore, produce obscure tints; while pure and vivid colors would require a perfectly definite absorption of one portion of the colored rays, leaving the remainder to produce the true complementary color. This being the case, we may expect these brown tints to occur when the need of protection is very slight, or even when it does not exist at all, always supposing that bright colors are not in any way useful to the species. But whenever a pure color is protective, as green in tropical forests or white among arctic snows, there is no difficulty in producing it, by natural selection acting on the innumerable slight variations of tint which are ever occurring. Such variations may, as we have seen, be produced in a great variety of ways, either by chemical changes in the secretions or by molecular changes in surface structure, and may be brought about by change of food, by the photographic action of light, or by the normal process of generative variation. Protective colors, therefore, however curious and complex they may be in certain cases, offer no real difficulties.

Theory of Warning Colors.—These differ greatly from the last class, inasmuch as they present us with a variety of brilliant hues, often of the greatest purity, and combined in striking contrasts and conspicuous patterns. Their use depends upon their boldness and visibility, not on the presence of any one color; hence we find among these groups some of the most exquisitely colored objects in nature. Many of the uneatable caterpillars are strikingly beautiful; while the Danaidæ, Heliconidæ, and protected groups of Papilionidæ comprise a series of butterflies of the most brilliant and contrasted colors. The bright colors of many of the sea-anemones and sea-slugs will probably be found to be in this sense protective, serving as a warning of their uneatableness. On our theory none of these colors offer any difficulty. Conspicuousness being useful, every variation tending to brighter and purer colors was selected, the result being the beautiful variety and contrast we find.

But when we come to those groups which gain protection solely by being mistaken for some of these brilliantly colored but uneatable creatures, a difficulty really exists, and to many minds is so great as to be insuperable. It will be well, therefore, to endeavor to explain how the resemblance in question may have

been brought about. The most difficult case, which may be taken as a type of the whole, is that of the genus *Leptalis* (a group of South American butterflies allied to our common white and yellow kinds), many of the larger species of which are still white or yellow, and which are all eatable by birds and other insectivorous creatures. But there are also a number of species of *Leptalis* which are brilliantly red, yellow, and black, and which, band for band and spot for spot, resemble some one of the Danaidæ or Heliconidæ which inhabit the same district, and which are nauseous and uneatable. Now, the common objection is that a slight approach to one of these protected butterflies would be of no use, while a greater sudden variation is not admissible on the theory of gradual change by indefinite slight variations. This objection depends almost wholly on the supposition that when the first steps toward mimicry occurred, the South American Danaidæ were what they are now, while the ancestors of the Leptalides were like the ordinary white or yellow Pieridæ to which they are allied. But the danaioid butterflies of South America are so immensely numerous and so greatly varied, not only in color but in structure, that we may be sure they are of vast antiquity and have undergone great modification. A large number of them, however, are still of comparatively plain colors, often rendered extremely elegant by the delicate transparency of the wing membrane, but otherwise not at all conspicuous. Many have only dusky or purplish bands or spots, others have patches of reddish or yellowish brown, — perhaps the commonest color among butterflies, —while a considerable number are tinged or spotted with yellow, also a very common color, and one especially characteristic of the Pieridæ, the family to which *Leptalis* belongs. We may therefore reasonably suppose that in the early stages of the development of the Danaidæ, when they first began to acquire those nauseous secretions which are now their protection, their colors were somewhat plain, either dusky with paler bands and spots, or yellowish with dark borders, and sometimes with reddish bands or spots. At this time they had probably shorter wings and a more rapid flight, just like the other unprotected families of butterflies. But as soon as they became decidedly unpalatable to any of their enemies, it would be an advantage to them to be readily distinguished from all the eatable kinds; and as butterflies were no doubt already very varied in color, while all probably had wings adapted for pretty rapid or jerking flight, the best distinction might have been found in outline and habits;

whence would arise the preservation of those varieties whose longer wings, bodies, and antennæ, and slower flight, rendered them noticeable, — characters which now distinguish the whole group in every part of the world. Now, it would be at this stage that some of the weaker-flying Pieridæ which happened to resemble some of the Danaidæ around them in their yellow and dusky tints, and in the general outline of their wings, would be sometimes mistaken for them by the common enemy, and would thus gain an advantage in the struggle for existence. Admitting this one step to be made, and all the rest must inevitably follow from simple variation and survival of the fittest. So soon as the nauseous butterfly varied in form or color to such an extent that the corresponding eatable butterfly no longer closely resembled it, the latter would be exposed to attacks, and only those variations would be preserved which kept up the resemblance. At the same time we may well suppose the enemies to become more acute and able to detect smaller differences than at first. This would lead to the destruction of all adverse variations, and thus keep up in continually increasing complexity the outward mimicry which now so amazes us. During the long ages in which this process has been going on, many a *Leptalis* may have become extinct from not varying sufficiently in the right direction and at the right time to keep up a protective resemblance to its neighbor; and this will accord with the comparatively small number of cases of true mimicry as compared with the frequency of those protective resemblances to vegetable or inorganic objects whose forms are less definite and colors less changeable. About a dozen other genera of butterflies and moths mimic the Danaidæ in various parts of the world, and exactly the same explanation will apply to all of them. They represent those species of each group which, at the time when the Danaidæ first acquired their protective secretions, happened outwardly to resemble some of them, and have by concurrent variation, aided by a rigid selection, been able to keep up that resemblance to the present day.[1]

(To be concluded.)

[1] For fuller information on this subject the reader should consult Mr. Bates's original paper, Contributions to an Insect-Fauna of the Amazon Valley, in Transactions of the Linnean Society, vol. xxiii., p. 495; Mr. Trimen's paper in vol. xxvi., p. 497; the author's essay on Mimicry, etc., already referred to; and, in the absence of collections of butterflies, the plates of Heliconidæ and Leptalidæ, in Hewitson's Exotic Butterflies, and Felder's Voyage of the Novara may be examined.

THE ROCKY MOUNTAIN LOCUST.[1]

BY C. V. RILEY, PH. D.

THE subject which you have assigned to me is entitled The Rocky Mountain Locust and the Army Worm. Both these insects are extremely injurious to the agriculture of the United States, and as it would be difficult to do justice to both in the compass of a brief address I shall confine my remarks at the present time to the first named. So much has been written and said, by myself and others, upon this Rocky Mountain locust during the past two or three years that it would seem difficult indeed to say anything about it that is new or of value. Yet I may safely assert that most of the definite and accurate knowledge regarding its habits and life history was first given to the world during the present year.

Though popularly known as the "grasshopper," yet the term "Rocky Mountain locust," proposed by myself, has been very generally adopted as most appropriate. The insect belongs to the same family as the locusts of Scripture. The term grasshopper is very loosely applied to many insects that hop about in grass, but strictly belongs to the long-legged, long-feelered species. Locusts have short and stout legs, short and stout feelers, and are mute, or, if they stridulate at all, do so by rubbing the hind thighs against the sides of the folded front wings; their prevailing color is brown; they are gregarious, and they oviposit in the ground by means of short, drilling valves. True grasshoppers have long and slender legs and feelers, and stridulate by vibrating the front wings, which in the males are furnished, generally near the base, with talc-like plates crossed by enlarged and hollow veins; their prevailing color is green; they are solitary, and they mostly oviposit in different parts of plants, by means either of a sword- or scimeter-shaped ovipositor. It is the grasshoppers, the katydids (which are a tree-inhabiting section of them), and the crickets which make field and wood resound with shrill orchestry at the present season; but the locusts take no part in the concert. While our insect belongs, therefore, to the same family as the locusts of Scripture, those people are greatly at sea who imagine it to be specifically identical with any of the Asiatic or European species. It is known to entomologists as

[1] An address delivered at the Chicago session of the American Agricultural Congress, in September, 1877. Some portions are omitted for want of space. — ED.

Caloptenus spretus, and is purely American, since it does not inhabit any other continent.

Evolutionists believe — and I am one of them — that existing species are but the modified descendants of preëxisting species. The present species of a genus have at some time, more or less remote, had a common ancestry. All life exhibits a certain power of adaptation to surrounding conditions, and through what is known as "natural selection" (two words which by Darwin's pregnant pen have come to express volumes of facts and consequences), coupled with other less easily formularized laws, the fauna and flora of the globe have been as profoundly changed as have its physical conditions. The influences that have thus worked in the past are still working at present — less rapidly, perhaps, in the main, but none the less effectually. Among higher and more complex animals the changes are slow and not very noticeable; the species have become, in most cases, markedly differentiated, and their characters are well fixed. Among lower organisms these changes are more obvious, and naturalists are sorely puzzled in their endeavors to grasp and express them. This is especially the case among insects. We have the simple variation from the typical characters of a species; we have phytophagic varieties, or those departures from the type that result from the kind of food assimilated during growth; we have phytophagic species, or those variations which have become fixed and permanent in the adolescent or immature stages through some peculiar and fixed habit, without having yet modified the imago or mature state; we have geographical variation, increasing — usually with distance — until the separation from the type is sufficient to be indicated by what we call race; we have seasonal variation, sexual variation, and, finally, we have the terms dimorphism, heteromorphism, and many other *isms*, to express still other variations. In short, in the strain, the breed, the sport, the tribe (in the popular sense), the variety, and the race, we have so many terms invented to indicate some of the more patent steps in the evolution of one species from another, and between them all there are so many shades of variation for which no words have yet been coined, that the naturalist who takes a comprehensive view of life upon our planet finds that what we have chosen to call *species* are often with difficulty separated from each other; that they have, in fact, no real existence in nature. All our classificatory divisions are more or less conventional. They are excellent as aids to thought and study, but misleading when be-

lieved — as they popularly are — to express absolute creations that have existed for all time.

As with other species, so it is with the locust under consideration. The species is a denizen of the plains regions of the Rocky Mountains to the west and northwest of us. It breeds continuously and comes to perfection only in those high and dry plains and prairies; and though at intervals it overruns much of the lower, moister country to the east and southeast, yet it never extends in a general way to the Mississippi. But there are species east of the Mississippi that are so closely allied to it that the ordinary farmer cannot, without a little special knowledge, appreciate the difference, and entomologists, even, are not of a mind as to whether they should be called species, varieties, or races, etc. The two species most closely allied to the Rocky Mountain locust are the red-legged locust (*Caloptenus femur-rubrum*) and the Atlantic locust (*Caloptenus Atlantis*). Both are wide-spread species, but are either rare or do not occur in the home of *spretus*. The differences between the three species I have elsewhere given in detail; for the present purpose it suffices to say that the distinguishing characters, most easily observed by the non-entomologist, are the relative length of the wing and the structure of the terminal joint of the male abdomen. The Rocky Mountain species has the wings extending, when closed, about one third their length beyond the tip of the abdomen, and the last or upturned joint of the abdomen narrowing like the prow of a canoe, and notched or produced into two tubercles at top. The wings of the red-legged locust extend, on an average, about one sixth their length beyond the tip of the abdomen, and the last abdominal joint is shorter, broader, more squarely cut off at top, without terminal tubercles, and looks more like the stern of a barge.

The Atlantic locust, though smaller than either, is in other respects intermediate between the two, but in relative length of wing and structure of the anal joint in the male, most related to *spretus*.

We should encourage the locust's natural enemies. Practically this is not possible with many of the smaller parasitic and predaceous kinds; they are beyond our control. With many of the larger locust enemies, however, as in the case of birds, it is feasible. One of the most effectual ways of accomplishing it is to offer a reward for hawk-heads, as Colorado has done. The introduction of such hardy locust-feeding birds as the grackle and the

English rook may be attended with benefit, and the commission of which I am a member will try the experiment. The destruction of the eggs is of the utmost importance.

The experience of the present year has proved, what I have always insisted on, that in the more thickly-settled portions of the country, by proper organization and intelligent effort, man may master the young insects. Men of large experience admit that a crop of young locusts is not more difficult to cope with than a crop of weeds. It is different with the winged insect, and the question is: "Can anything be done to protect our farmers from the disastrous flying swarms?" At first view it would seem hopeless. Yet there is already a partial answer to the question. There is a popular notion that this pest breeds in and comes from sandy, desert countries. It is a popular error. The insect cannot live on sand, nor does it willingly oviposit in a loose, sandy soil. It does not thrive on cacti and sage-bush. It flourishes most on land clothed with grass, in which, when young, it can huddle and shelter. It can multiply prodigiously on those plains only that offer a tolerably rich vegetation, — not rank and humid as in Illinois, but short and dry, — such as is found over much of the plains region of the Northwest, already referred to. Now the destruction of the eggs, which is so practicable and effectual in settled and cultivated sections, is out of the question in those vast unsettled prairies; but the destruction of the young locusts is possible. Those immense prairies are not only susceptible of easy burning, but it is difficult to prevent the fire from sweeping over them. Now some system of preventing the extensive prairie fires that are common in that country in fall, and then subsequently firing the prairie in the spring, after the bulk of the young hatch, and before the new grass gets too rank, would be of untold value if it could be adopted. At first blush such a proposition seems utopian, but the more I study the question, and the more I learn of those breeding-grounds, the more feasible the plan grows in my mind. The Dominion government has, fortunately, a well-organized mounted police force which constantly patrols through the very regions where the insects breed, north of our line. This force is intended to see that the peace is kept, to watch the Indians, to enforce the laws, and perform other police duties. It could be utilized, without impairing its efficiency as a police force, in the work I have indicated; or it might be augmented for that same work. I have conversed with the Canadian ministers of agriculture and of the interior, and

with Governor Morris, on the subject, and they see nothing impracticable in the plan. We have on this side the line a number of signal stations and military posts in the country where the insect breeds. Now, I would have our own military force coöperate with the Dominion police force as a locust vigilance committee. Under the intelligent guidance and direction of some special commissioner or commission, I would have that whole country systematically studied every year by such a force, with reference to the abundance or scarcity of the locusts. I would have such a vigilance force, by a proper system of fire-guards and surveillance, prevent the fall fires in sections where the insects or their eggs were known to abound, in order to burn them at the proper time the following spring; and where such precaution was not possible or had failed, and the winged insects at any season were numerous, I would have their movements carefully watched, and communicated daily to the signal officers, to be by them communicated to the farmers. In this way the latter could be fully forewarned of approaching danger. I would have the Western farmers adopt some general plan of defense against possible invasion. The straw that is now allowed to rot in sightless masses as it comes from the thrasher, and that encumbers the ground unless burned, should be utilized. Let it be stacked in small pyramids at every field corner, and there let it remain until the locusts are descending upon the country. Then let the farmers in a township or a county, or in larger areas, simultaneously fire these pyramids, using whatever else is at hand to slacken combustion and increase the smoke, and the combined fumigation would partially or entirely drive the insects away, according as the swarm was extended or not. In short, not to weary you, I believe, first, that by proper coöperation on the part of the two governments interested, the excessive multiplication of this destructive insect may be measurably prevented in its natural breeding-grounds, and that the few thousand dollars that would be necessary to put into operation intelligent coöperative plans were most trifling in view of the vast interests at stake. In fact, with an efficient and properly organized department of agriculture, liberally supported by Congress, and aided by the war department and the signal bureau, the plan could soon be perfected and carried out at minimum expense. I believe, secondly, that where the insect's multiplication cannot be prevented in its natural breeding-grounds our farmers in the more thickly-settled sections may, by the use of smoke, measurably turn the course of invading swarms and

protect their crops, — obliging the insects to resort to the uncultivated areas.

Were the injury to continue for another three or four years as it has for the past four, and were the Western farmers to suffer a few more annual losses of forty million dollars, such schemes as I have suggested would soon be carried out. The danger is that during periods of immunity, indifference and forgetfulness intervene until another sweeping disaster takes us by surprise.

Rules greatly assist in the solution of any problem, and in proportion as we get at a knowledge of the laws governing this Rocky Mountain locust shall we be able to overcome it. The country which it devastates is so vast, and the question as to its origin and the causes of its disastrous migrations is so complicated, that a limited study is apt to beget doubt as to whether there are any laws governing the insect or any rules for our guidance. The facts of sociology are so innumerable that the ordinary gleaner of them reaps but confusion. It requires the genius and comprehensiveness of a Herbert Spencer to deduce principles therefrom, — to perceive the laws by which society is molded. The vain, delusive confidence begot of first study of any difficult subject — that follows superficial knowledge, — reacts in doubt and diffidence upon deeper delving and more thorough study.

"The more I learn the less I know" is a paradoxical but very common remark. It is only after passing through this period of doubt in any inquiry that we can begin to see the light; and in this locust inquiry it is only after accumulating facts and experiences until they almost overwhelm us with their complexity that we can begin to generalize and deduce rules.

The history of this insect east of the Rocky Mountains, when viewed from a comprehensive stand-point, presents certain well-marked features. We have, first, the migrations of winged swarms in autumn from the higher plains of the West and Northwest, into the more fertile country south of the 44th parallel and east of the 100th meridian. It is the more fertile and thickly-settled country south and east of the limits indicated which suffers most, both from the insects which sweep over it and from the young that hatch in its rich soil; and it is principally this country which I have designated as being outside the insect's native home, and in which it can never become a permanent resident. The species does not dwell permanently even in much of the country north and west of those lines, but it flour-

ishes more and more toward the northwest. In short, the vast hot and dry plains and prairies of Wyoming, Dakota, and Montana, and the immense regions of a similar character in British America, comprising what is known as the third prairie plateau or steppe, are congenial breeding-grounds, and supply the more disastrous swarms which devastate the lower Missouri and the Mississippi valleys. That northwest country may be depicted as a vast undulating prairie sea, now stretching in sandy barren tracts which bring forth little else than the cactus or sage-bush; now rolling for hundreds of miles, and covered with the buffalo grass (*Bucloe dactyloides*) and other short nutritious grasses, and again producing a ranker prairie growth wherever there is increase of moisture. Another peculiarity of that country is that though the spring opens as early, even away up in the valley of the South Saskatchewan, as it does in Chicago, yet the vegetation often becomes parched up and burned out by the early part of July. Now, *Caloptenus spretus*, though coming to perfection in high and dry regions, is nevertheless fond of succulent vegetation, and instinctively seeks fresh pastures whenever those of its own home are dried up. It may sometimes happen, indeed, that the species will die in immense numbers if the scant vegetation where it breeds should dry up before the acquisition of wings, just as another species (*Œdipoda atrox*) has perished in immense numbers the present season in California by the excessive drought that has prevailed there; but ordinarily the insects will be full grown and fledged before the parched season arrives, and the ample wings of the species prove its salvation. Again, it may become so prodigiously multiplied during certain seasons that everything green is devoured by the time its wings are acquired.

"In either case, prompted by that most exigent law of hunger, — spurred on for very life, — it rises in immense clouds in the air to seek for fresh pastures where it may stay its ravenous appetite. Borne along by the prevailing winds that sweep over these immense treeless plains from the northwest, often at the rate of fifty or sixty miles an hour, the darkening locust clouds are soon carried into the moist and fertile country to the southeast, where with sharpened appetites they fall upon the crops, a plague and a blight. Many of the more feeble or of the more recently fledged perish, no doubt, on the way; but the main army succeeds, with favorable wind, in bridging over the parched country which affords no nourishment. The hotter and dryer the season, and the greater the extent of the drought, the earlier

will they be prompted to migrate, and the farther will they push on to the east and south."[1]

We have, second, the return migration toward the northwest from the country south and east of the lines already indicated, of the progeny of invading swarms, as soon as wings are acquired the next summer. Time will not permit me to present the explanation of this return migration. In the work just quoted I have discussed its causes, the reasons why the species cannot permanently thrive in the Mississippi valley, and the conditions which prevent its establishment there.

We have, third, the eastern limit of the insects' spread along a line broadly indicated by the 94th meridian, and the consequent security from serious injury east of that line.

These three features of our disastrous swarms — the return migration from the southeast country (which implies only temporary injury therein), and the eastern limit, — may be stated as laws governing the insect east of the Rocky Mountains. They have constantly been urged by me, and the present year's experience has confirmed and verified them. I think I may safely present a fourth, namely, that the eggs are never laid thickly two successive years in the same regions.

In mapping out the country in Kansas and Missouri in which eggs had been laid most thickly in 1876, I was struck with the fact that the very counties in which the young insects had been most numerous and disastrous in 1875 were passed by or avoided, and had no eggs of any consequence laid in them in 1876. The fact was all the more obvious because the insects did much damage to fall wheat, and laid eggs all around those counties, to the north and south and west. From the exhaustive report on the insect in Minnesota, made by Mr. Allen Whitman, it was also very obvious that those portions of that State which had been most thickly supplied with eggs in 1875, and most injured by the young insects in 1876, were the freest from eggs laid by the late swarms of the latter year, notwithstanding counties all around them were thickly supplied. I was at first inclined to look upon these facts as singular coincidences only; but instances have multiplied. A remarkable one has been furnished me by Gov. A. Morris, of the northwest territory. You are well aware that in 1875 the locusts hatched out in immense numbers and utterly destroyed the crops in the province of Manitoba. Now, in 1876 they were very numerous over all the third prairie

[1] Locust or Grasshopper Plague, page 57. Rand, McNally, & Co., Chicago.

steppe of British America, and largely went to make up the autumn swarms that came into our own country a year ago. Governor Morris started late in July of 1876 from Winnipeg northwest to make a treaty with certain Indians, and during the first five or six days of August he encountered innumerable locust swarms all the way from the forks of the two main trails to Fort Ellice. The wind was blowing strong from the west all the time, — just the very direction to carry the insects straight over into Manitoba. The governor watched their movements with the greatest anxiety, fearing that the province would again be devastated as it had been the previous year. Yet during all the time he was passing through the immense swarms, they bore doggedly to the south and southeast, either tacking against the wind or keeping to the ground when unable to do so. Nothing was more remarkable than the manner in which they persisted in refusing to be carried into Manitoba. A few were blown over, but did not alight, and the province seemed miraculously delivered. Mr. Whitman tells me, again, that in settling the present year the insects avoided those counties in Minnesota in which they had hatched most numerously and done greatest injury, but selected such as had not suffered for some years past.

It is evident that there is more than mere coincidence in these occurrences, and I may say that upon looking more deeply into the matter I cannot find a single instance where eggs have been laid thickly for two successive years in any invaded country. This is a most important fact. During a season of great devastation there is a natural tendency among the more pious portion of the community to beseech the Almighty, by prayer, fasting, and humiliation, for deliverance. How greatly their faith must be strengthened by facts such as I have just stated! As a naturalist it is my province to study the reasons for the facts. Whether what I call the working of natural laws be called by others the instrumentality of Providence is quite immaterial.

To recapitulate, I think we may safely deduce the following four rules as governing the Rocky Mountain locust east of the mountains from which it takes its name: —

(1.) The northwest origin of the more disastrous fall swarms that overrun the more fertile country south of the 44th parallel and east of the 100th meridian.

(2.) The return migration toward the northwest of the insects that hatch in the country named.

(3.) The eastern limit of the insects' spread along the 94th meridian.

(4.) No two successive hatchings of an extensive and disastrous nature can take place in the same region.

The possibility of exception to the rules would be in keeping with the character of all rules; but I am convinced that the exceptions will ever prove most trifling. Now there is a deal of satisfaction to be drawn by our farmers from these rules, which not only limit locust disaster but enable them to anticipate events; and I need hardly state that the accuracy of my own prognostications, repeatedly made during the past three or four years, was in no small degree due to them.

We have had the spectacle of the Rocky Mountain locust, in what I call the return migration, flying over some parts of the vast territory from the 29th parallel to the Dominion boundary line, and from the 94th meridian to the mountains, all along from the end of April till the beginning of August, and with so little injury that, with the exception of the case in Montana, just mentioned,[1] the question everywhere asked is, Where have the flying 'hoppers gone? What has become of them? I answer that, as in previous years, and as I have always held would be the case, they were, in the main, so diseased and parasitized that they dropped in scattered numbers and mostly perished on their northward and northwestward journey. This is no theory, but known to have been the case in the more thickly-settled parts of Kansas, Nebraska, Iowa, and Minnesota, from which the insects that had dropped have been reported, and in some cases sent to me. But as the flight is for the most part over the vast and thinly-settled plains of Indian Territory, Kansas, Nebraska, and Colorado, the number that has dropped and been lost to sight in said plains is infinitely greater than that which has been observed to come down in the more thickly-settled regions to the east.

The more dense and extensive swarms that flew before the 1st of July reached, I have little doubt, the great thinly-settled plains and prairie region of Northwest Minnesota, Dakota, Montana, and British America, — embracing in the latter case most of the country between the projected line of the Canada Pacific and the boundary line, and between Manitoba and the Rocky Mountains. I found the insects sparsely spread over the rank prairies west of Brainerd along the Northern Pacific and along Red River; and by this I mean that a few would hop from the grass at every step, wherever I searched for them. I met with only here and there a straggler in Manitoba; but early in July

[1] Referred to in the portions omitted. — ED.

they flew from the south over the country west of the province, and reached the North Saskatchewan at several points, passing many miles north of Fort Carleton.

The insects that rose after the first week in July (mostly from restricted parts of Minnesota and Dakota) bore for the most part southwardly, while many of those which passed to the northwest earlier in the season returned. Thus, swarms more or less scattering have been passing for the past two months over parts of Iowa, Nebraska, and Kansas, in varying directions, but mainly to the south and southeast. They have lately reached into the Indian Territory. In no instance have they done serious damage, and the reports that come to me are singularly unanimous on this point. The movements of the insects that bred in Minnesota this year were very similar to the movements of those that bred there in 1876. They at first flew to the northwest, but were subsequently brought back, and traveled over parts of Iowa, Nebraska, and Kansas. The difference between the two years is that the flights that thus turned back on the original course in 1876 were recruited and followed by immense and fresh swarms from the northwest plains regions, where, far beyond the boundary line, they hatched and bred innumerably; whereas the Minnesota swarms of 1877 have not been recruited because there were few eggs laid in 1876, and no insects of any consequence reared in 1877 in said northwest country. It is upon this fact that I have founded the belief in no serious devastation in the southeast country this fall.

To those who pay little attention to the subject the disappearance of the swarms that left the Mississippi Valley is matter for wonder. "What is hit is history, but what is missed is mystery." Who, at the explanation of some simple trick or piece of legerdemain, has not smiled to think how easily he was baffled! But there are those who prefer the mystery of ignorance, and would much rather believe that the locusts have vanished in the heavens or been swept into the ocean than accept any explanation; and there are others who, from sectional feelings, would much rather believe that the insects have flown to Canada and New England than accept the facts.

GLACIAL MARKS ON THE PACIFIC AND ATLANTIC COASTS COMPARED.

BY A. S. PACKARD, JR.

WHILE in Europe one can readily interpret the ancient moraines and other ice marks by reference to existing glaciers with their moraines, ice grooves, and scratches, the American geologist is usually forced to make a long journey to Switzerland, the Pyrenees, or to Norway in order to observe such phenomena, now to be seen on an extended scale only in Arctic America and in Greenland. However, the recent discovery by Mr. Clarence King of a few small glaciers in the Sierra Nevada of California has, with the observations of others, shown, what was quite unsuspected a few years ago, that not only the Rocky Mountains but the Sierra Nevada have been the seat of extensive glaciers, which in the Sierra Nevada descended to a point between two and three thousand feet above the sea, or as low as five or six thousand feet in the Rocky Mountains. We had followed up these discoveries with much interest, and made during our entomological journeys cursory observations upon ancient glaciers and rounded rocks in the Rocky Mountains in 1875, and again during the early part of the past summer in Montana and parts of adjoining Territories. In the course, however, of an extended journey through Middle and Northern California, portions of Oregon, Washington Territory, and Vancouver Island, undertaken in the interests of the United States Entomological Commission, I was enabled from the stage-coach, or on horseback, or in the course of my entomological walks, to observe certain more salient points, which some experience in past years in the study of surface geology in Switzerland and Norway, as well as in New England and Labrador, rendered of a comparative nature and proved of great personal interest. Indeed, I have been struck with the remarkable parallelism between all the more general glacial phenomena, whether observed in the Old or on the Atlantic or Pacific borders of the New World.

A rapid and too cursory inspection of the Whitney Glacier on Mount Shasta, of the moraines upon its lower extremity and of the ancient ones on the flanks of the mountain, which have been in part described by Mr. King, though much still remains to be studied, has enabled us, as never before, to comprehend the

peculiar features in the system of ancient modified moraines of Central and especially Southern New England, including Nantucket, Martha's Vineyard, and the Elizabeth Islands. It seems to us plain enough that the ridges, or osars, and tumuli of gravel, as well as the sudden depressions among them, so frequent in New England, particularly about Salem and Andover, Mass., and in Maine, are of direct glacial origin.

The ascent of the crater cone of Mount Shasta was made during a short stay at Sisson's Station, at the base and to the southwest of the mountain, under the guidance of Mr. J. H. Sisson, who as the former guide of Mr. King and others was familiar with the moraines and glaciers of this magnificent peak. Never had I seen such a pure mountain form, chiseled out by the subterranean forces. No mountain, so far as we know, in Europe or America north of Mexico approaches it in its treble qualities of isolation, its regular conical form, and great altitude. Its summit for about four thousand feet is in large part covered with snow fields, and three glaciers, the Whitney, McCloud (on the eastern side), and Ash Creek (on the northeast), descend its flanks to or near the timber line, which is at an elevation of about nine thousand feet. I afterwards, in Oregon, had distant views of Mounts Hood, Adams, and St. Helens, members of the same family of extinct volcanoes, which form snow-capped, isolated cones rising about eight or nine thousand feet above the Cascade Range, which seemed dwarfed by their presence. I ascended the crater cone of Shasta by the trail leading from Sisson's hotel, and descended the eastern side to a point immediately overlooking the Whitney Glacier, which is about three miles long and extends from the summit of Shasta Peak down to or quite near the line of trees. With a good glass I could study the surface of the glacier for its whole length. The following account of the moraines and glacial marks is taken nearly as I wrote it down on the spot: —

August 25th we camped at the foot of the crater cone, and after a clear, cold night, the ice forming nearly an inch thick, we made an early start and reached the summit of the crater before nine o'clock. Here a magnificent view was spread out at our feet.

To the northwest lay the Siskiyou Range and Pilate's Knob, to the west the serrated range of the Salmon Mountains, while to the south rose to the altitude of about twelve thousand feet Lassen's Peak, its snow-clad summit glistening in the sun. The eye

also ranged northeasterly over the lava plains, where the Modoc war formerly raged, and over the Klamath Lakes and Tule Lake. At our feet yawned the crater, about a thousand feet deep, its rim guarded by sharp, jagged pinnacles, while immense snow fields ran down to the bottom, in which lay two small frozen lakes.

On reaching our point of view overlooking the glacier, Mr. Sisson, who though he has observed the glacier for many years, had not now seen it for four years, remarked that it had diminished very considerably, the surface appearing at least seventy-five or one hundred feet lower than when he saw it four years previous. The glacier lies in a gulch on the north side of the mountain, and heads in a field of snow, or *névé*, which Mr. Sisson told me was continuous with the McCloud Glacier. The upper end must be over 13,500 feet in elevation. The surface is white and clean near the top. Ice cascades and crevasses begin very near the upper termination. On the upper portion on the east side, under a perpendicular wall of rock, is a lateral moraine, and a little farther down, where the glacier abuts against the crater cone, is a lateral moraine on the west side. The eastern lateral moraine ends in three ridges of dirt and loose masses of rock, and the terminal moraine covers the bottom of the glacier and connects the two lateral moraines. The end of the glacier, instead of being free of detritus, pushing the mass before it as in most European glaciers, runs under the terminal moraine for a considerable distance, the ice here and there projecting above the surface of the moraine. When these should melt away hollows would be formed, like those seen in the ancient moraines about Salem, Mass., and Southern New England. Large, angular bowlders lie scattered over the lower part of the glacier. The glacier extends nearly to the timber line, and seemed by a rough guess to be about three miles long. At the middle of the glacier the walls of lava rock are but slightly worn by the ice, owing to the hardness of the rock, and no grooves were to be seen. The glacier, judging by the frequent explosions, was in motion.

At and beyond the end of the present terminal moraine lies the former extension of it, constituting naked plains; and below, the still more ancient moraine, showing the former size of the glacier, and comprised of a series of well-wooded hills. A muddy stream with a white bed and banks runs north into Shasta Valley from the end of the glacier. Near the termination of the glacier on the northeast side are three well-marked old naked moraines, at least

two miles long, sweeping around to a small extinct volcano perhaps one thousand feet in height, ending in nine or ten small cones. These moraines apparently connect with the terminal moraine of a small, narrow glacier just east of Whitney's, and which must formerly have made an upper eastern branch of it. As evidence of the former extension of the glacier down into the Shasta Valley are two well-rounded hills, evidently regularly moulded by ice, and forming flattened domes.

The trail from the cone to Sisson's house lies over a lava ridge, formed of loose, angular bowlders of the reddish lava composing the cones, with a few bowlders of a whitish rock. For several miles it was arranged in transverse terraces or benches a few feet in height, with rock masses piled upon them in slightly concentric parallel transverse rows, the interspaces being clear of rocks. It extends about eight miles from the base of the cone down into the forest, and is so irregular, rough, naked, and jagged that Mr. Sisson has well christened it the "Devil's Garden." At first it seemed to me to be simply an old lava stream, like those I had seen on Mount Vesuvius; but after riding several hours over and past it, both on my way to and from the cone, and noticing the foreign bowlders on its surface, and two lateral moraines on the sides, it seemed without doubt to be a long, narrow, median moraine. For the greater portion of its length the sides are remarkably steep and regular, and it has a remarkable external resemblance to the gravel ridges in Andover, Mass., and other portions of New England.

To the southward, between the cone and the main peak, is a small park in which a glacier must formerly have rested; on the outer western edge is a small terminal moraine, flanked by a lateral moraine on each side.

As the crater cone is composed of a light reddish lava, while the much older main peak consists of a pale, bluish-gray trachyte, it is easy to distinguish the respective origins of the long lateral moraines which extend from the two peaks, the last red lava ridges extending down from the crater cone, lying parallel to the northwesternmost pale gray moraine of the main peak. The trachyte moraines even extend ten or twelve miles down to the west side of the stage road a little north of Sisson's hotel, where there are several conical hills of *débris*, which had evidently come from the main peak of Mount Shasta.

The fact of most interest connected with the Whitney Glacier is that the ice is concealed for a considerable distance by the ter-

minal moraine, and that by the melting of the ice the hillocks would not only remain, but deep hollows would be left. Now we have precisely the same contour of the surface over a large part of Essex County, Mass., particularly about Salem and on the islands on the southern shore of New England. The peculiar scenery about Salem and Andover, and on Naushon Island, Martha's Vineyard, etc., can be fully explained by a reference to the terminal moraines on the glaciers of Mount Shasta, as in fact has been done by Mr. King.[1] Again, I believe the so-called *kames*, *osars* or *eskers* of New England, such as Indian Ridge in Andover, Mass., and similar horsebacks in the White Mountains and in Maine, which I have examined, are much like the long, slender ridges of gravel and bowlders which lie on the flanks of Mount Shasta. Without much doubt the bulk of the glacial drift of the Northern Atlantic States was ground-moraine material, while a large proportion formerly covered the ice sheets, often thin and broad, which spread out over the hilly portions of the country; and the gravel ridges or eskers were lateral moraines, though perhaps also in part terminal, which have been partly rewashed by fresh or salt water.

Very interesting moraines were again seen on both sides of the stage road in Butteville, Shasta Valley. A remarkable one, evidently derived from the crater cone, and which must be ten or fifteen miles in length, is composed of small bowlders of reddish lava, arranged in transverse rows, with clear interspaces, the ridges not being more than a foot or two high, the bowlders being much smaller and less angular, having traveled farther than those in the Devil's Garden.

The glacial phenomena about Puget Sound and the southern extremity of Vancouver Island, about Victoria, were of a high degree of interest. Leaving the Columbia River at Kalama the Northern Pacific runs through a broad, park-like valley covered originally with pine forests, the valley widening towards Tacoma, at the head of Puget Sound, the surface being flat or undulating, with quite well-marked moraine hills and gravelly ridges, resembling those in New England. This region, like the New England coast, has been under the sea, and the waters of Puget Sound have washed and rewashed the original moraines, so that the scenic features are strikingly similar to the familiar plains and fields and ridges about Boston and Salem, as well as Southern

[1] Mountaineering in the Sierra Nevada, 1872; and Some Remarkable Gravel Ridges in the Merrimac Valley, by Rev. G. F. Wright, 1877.

Maine. Here, evidently, the moraines had come down on glaciers from the Cascade Range, the source mainly perhaps from Mount Rainier, now a lofty, snow-clad cone like Mount Hood.

The former glaciers about Puget Sound were apparently a part of the series now existing in Alaska and described by Mr. W. H. Dall. Along the railroad track, within eight or ten miles of Tacoma, was a series of twelve or fifteen low, gravel ridges as level and with as regular a slope as fortifications. They run north by east and south by west, in a course generally parallel with the Cascade Range. I could not but compare them with the series of transverse ridges on the Mount Shasta moraines, and regard them as marking the steps in the retreat of a broad, thin mass of ice extending into one of the arms of Puget Sound from the neighborhood of Mount Rainier.

The shores of Puget Sound from Tacoma to Port Townsend are lined with a series of sands and gravels capping marine clays, in all respects like the cliffs of Massachusetts Bay and the Maine coast; and indeed the scenic features of Puget Sound with its many long, narrow reaches recall the lakes of Maine and Southern Norway. But at Vancouver Island, the resemblance is still more striking. Here the rocks in several localities about Victoria, on the shores of the Straits of Fuca, are as deeply furrowed and scored as I have seen anywhere on the coast of New England or of Norway. The trap and syenite down to the water's edge are smoothed and polished, with often deep furrows several inches wide, all running north 10° west, and south 10° east. The glacier which made them must have come from the centre of Vancouver Island, which is high and mountainous. Particularly interesting was the presence of fossil quaternary shells in the clay which covered the rocks, and which in color and scenic features exactly reproduced that formation, so familiar to me on the coast of Maine.

The clays were fine, stratified, though perhaps less so than Atlantic coast clays, with bowlders, mostly angular, but some well scratched and glacier-worn. These beds graduated above into regularly stratified pebbly, or gravelly, or sandy beds capped by black mold containing Indian shell heaps. The fossil shells and barnacles occurred from two to ten feet above the sea level. The species obtained were submitted to Mr. R. E. C. Stearns of the University of California, who kindly named them for me. They are enumerated in accordance with their relative abundance, the *Cardium corbis* being by far the most common.

Cardium corbis Martyn. Now a common Pacific coast shell.
Schizothærus Nuttalli Conrad, " " " "
Purpura crispata Chemnitz, " " " "
Mytilus modiolus Linn., " " " "
Leda fossa Baird. One perfect example.

The valves of an enormous barnacle (probably *Balanus tintinnabulum*) frequently occurred. It lives abundantly on the rocks about Victoria.

Glacial phenomena of quite a different nature were observed in the Yosemite Valley. From a hasty examination of the valley and its surroundings from Glacier Point, as well as different localities in the valley itself, it seemed plain enough that the valley, originally due to a series of faults as described by Professor Whitney and Mr. King, had become filled with ice continuously with the upper valley, as high up at least as the summit of Mount Starr King, which is a rounded dome; the source of the supply being the high peaks of the Sierra, such as Mounts Dana and Lyell, which are jagged and not molded by ice, all the peaks below having been rounded and worn by ice, while the sides of the valley in the more exposed places, and the North Dome and Half Dome, have been, as described by Mr. John Muir, molded and smoothed by the ice. The walls of the outlet, or lower valley, seemed also to have been molded by ice.

The history of the valley appeared to us somewhat in this wise: After its present shape had been marked out, and the mountains round about had assumed their present shape, the result of atmospheric erosion during the later tertiary period, the climate changed, the Sierra was covered with glaciers, and the Yosemite Valley was filled to overflowing with ice. It melted, and filled the bottom of the valley, which now forms a level park. The small, low, terminal moraine at the lower end of the valley, which formerly dammed the Merced, was finally cut through by the river and the park drained, and the present aspect of this wonderful cañon succeeded. This is the history of many valleys which I have seen in New England, Labrador, and Scandinavia, and the parallelism between them seems remarkably exact.

RECENT LITERATURE.

BOBRETZKY'S RESEARCHES ON THE DEVELOPMENT OF CEPHALOPODA.[1] — This is an elaborate work on the development of the cuttle-fishes belonging to the genera Loligo and Sepia. It is based on thin sections of the eggs, and has every appearance, from the plates, of being a critical and exhaustive treatise. Although the text is in Russian, an explanation of the plates is given in German. It is unfortunate for the English reader that no synopsis of the points made by the author is given either in French or German. Professor Bobretzky is also the author of a work on the embryology of the Crustacea, published at Kiew in 1873, and of later works on the same subject. Russia is rapidly taking the foremost rank in zoölogy. In comparative embryology she is at this moment on the whole in advance of England, the United States, or France. Such embryologists as Kowalevsky, Metznikoff, Bobretzsky, Ganin, Melnikow, and Ussow, nearly all, we believe, trained in German universities, have carried Russian biological science to high-water mark.

NINTH ANNUAL REPORT OF THE U. S. GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES.[2] — This Report shows the work done by the Survey in Colorado during 1875. Dr. Hayden announces that a map of the State is nearly ready, and when finished "Colorado will have a better map than any other State in the Union, and the work will be of such a character that it will never need to be done again. Colorado will never support so dense a population that a more detailed survey will be required."

The Report forms a bulky volume of over eight hundred pages. Part I., *Geology*, contains the report of Dr. C. A. Peale, F. M. Endlich and W. H. Holmes, and B. F. Mudge. Part II., *Geography and Topography*, comprises the reports of A. D. Wilson, Henry Gannett, G. B. Chittenden and G. R. Bechler. Part III., *Zoölogy*, contains the History of the American Bison, by J. A. Allen, and a Report on the Rocky Mountain Locust and other Insects now injuring or likely to injure Field and Garden Crops in the Western States and Territories, by A. S. Packard, Jr.

LIST OF THE VERTEBRATED ANIMALS IN THE LONDON ZOÖLOGICAL GARDEN.[3] — This list forms a bulky volume, handsomely illustrated with

[1] *Untersuchungen über die Entwickelung der Cephalopoden.* Von DR. N. BOBRETZKY aus Kiew. (Nachrichten der K. Gesellschaft der Freunde der Naturerkenntniss, Anthropologie und Ethnographie bei der Universität Moskow. Bd. xxiv. Heft 1, Moscow, 1877. 4to, pp. 73, with ten plates.

[2] *Ninth Annual Report of the U. S. Geological and Geographical Survey of the Territories, embracing Colorado and Parts of adjacent Territories.* Being a Report of Progress of the Exploration for the year 1875. By F. V. HAYDEN, U. S. Geologist. Washington, 1877. 8vo, pp. 827, with seventy plates and numerous maps.

[3] *List of the Vertebrated Animals now or lately living in the Gardens of the Zoölogical Society of London.* Sixth edition. 1877. London. 8vo, pp. 519.

thirty wood-cuts of many rare birds and mammals, and forms a nearly complete catalogue of all the living vertebrates received by the society during the past ten years. The volume will prove of a good deal of interest to the general student of these animals.

Recent Books and Pamphlets. — Annual Report of the Board of Regents of the Smithsonian Institute. Washington. 1877. 8vo, pp. 488.

On the Nymph Stage of the Embidæ. By R. M'Lachlan. (Extracted from the Journal of the Linnean Society, Zoölogy, vol. xiii.) 8vo, pp. 11, 1 plate.

The Post-Tertiary Fossils procured in the Late Arctic Expedition; with Notes on some of the Recent or Living Mollusca from the Same Expedition. By J. Gwyn Jeffreys. (From the Annals and Magazine of Natural History for September, 1877.) 8vo, pp. 12.

A Catalogue of the Birds of the Vicinity of Cincinnati, with Notes. By Frank W. Langdon, Naturalist's Agency. Salem, Mass. 1877. 8vo, pp. 17.

On the Tenacity of Life of Tape-Worms and their Larval Forms in Man and Animals. By Prof. Edward Perroncito. (Annali della Reale Accademia d'Agricoltura, 1876.) 8vo, pp. 4.

Members and Correspondents of the Academy of Natural Sciences of Philadelphia. 1877. 8vo, pp. 46.

Address to the Biological Section of the British Association, Plymouth, August, 1877. By J. Gwyn Jeffreys. London. 1877. 8vo, pp. 9.

The Summer Birds of the Adirondacks in Franklin County, New York. By Theodore Roosevelt, Jr., and H. D. Minot. 8vo, pp. 4.

Palæontological Bulletin. No. 25. Verbal Communication on a New Locality of the Green River Shales, containing Fishes, Insects, and Plants in a good State of Preservation. Made by E. D. Cope, before the American Philosophical Society, July 20, 1877. 8vo, pp. 10.

Notes of a New Genus of Annelids from the Lower Silurian. By George Bird Grinnell. (From the American Journal of Science and Arts. Vol. xiv. September, 1877.) 8vo, pp. 2.

GENERAL NOTES.

BOTANY.[1]

Poisonous Grasses. — In the September number of *Trimen's Journal of Botany* there is an interesting note by Dr. Hance on Intoxicating Grasses, which supplements a previous article on the same subject. A grass was sent by Dr. Aitchison from Kashmir which Professor Dyer determines as *Stipa Sibirica* Munro. Concerning this grass, Dr. Aitchison writes (date of August 4, 1875): "I have just been collecting some good specimens of a grass that is extremely common near Gulmuz. It grows in large tussocks, and is very poisonous to horses and cattle. The cattle are too knowing and will not eat it. Horses from the plains do eat it and die from its effects, but if quickly treated recover. They become comatose and lose the power of their limbs. It grows in the Scinde Välley also. Whilst there I heard of it and the cure, namely, smoking them, by making a large fire and keeping the horse's head in

[1] Conducted by Prof. G. L. Goodale.

the smoke. The nose commences to run first, and if it does so freely the beast is safe. The natives also say that if a cow eats it they give acid, unripe apricots, or any vinegar, which aids the recovery. A large number of the horses this year at Gulmuz were poisoned by it; none died, as all smoked their horses." In Dr. Hance's previous article, mention was made of a statement by a French missionary which is materially identical with the above. Professor Dyer suggests in a note to Dr. Hance that the Stipas may be only mechanically poisonous, like *Hordeum pratense*, but Dr. Hance adds that though it is indisputable that various grasses in Europe and Australia cause injury or death to cattle from their irritant properties, the special symptoms in the case of the *Stipa* and in *Melica* seem opposed to such a supposition. "In a recently published translation of Ptzevalsky's travels the Alashan poisonous grass is said to be a species of *Lolium*, and it is added that the native herds carefully avoid eating it."

In the September number of the *Botanical Gazette* Dr. J. T. Rothrock has a short note upon the *Leguminosæ* poisonous to stock. These plants are *Oxytropis Lamberti* in Colorado, *Hosackia Purshiana* in Arkansas, and two or three species of *Astragalus* in California.

A REMARKABLY LARGE OSTRYA VIRGINICA. — Mr. Robeson, of Lenox, has sent me the dimensions of a remarkable plant of *Ostrya Virginica*, which I found last summer growing near the roadside in West Stockbridge, Mass. I place it on record because it is more than twice as large as the specimens of this species mentioned in any of the works on American trees. Larger specimens, if they anywhere exist, should be reported, that more accurate information may be obtained on the development, under favorable conditions, of this tree. Mr. Robeson's measurements are, girt of stem at the ground 9 feet 11 inches, at 4 feet from the ground 7 feet 2 inches; height to first branches 6 feet 4 inches; spread of branches from east to west 47 feet, from north to south 45 feet; height of tree 48 feet 7 inches. — C. S. SARGENT.

ALPINE PLANTS. — Mr. C. G. Pringle, of Charlotte, Vermont, offers for exchange or sale a few sets of the Alpine plants of New England, the fruit of his extensive herborizing during the past summer in the White and Green mountains. Mr. Pringle's collections contain *Gentiana Amarella* var. *acuta* (AMERICAN NATURALIST, volume ii., page 620), *Anemone multifida*, *Astragalus Robbinsii*, *Gnaphalium supinum*, *Orchis rotundifolia*, *Danthonia compressa*, and all or nearly all the other rare plants of his region.

HOW PLANTS GUARD AGAINST ANIMALS AND BAD WEATHER is an English title for a German work which has been lately issued as a supplement to *Botanische Zeitung*. Otto Kunze, the author, has brought together within small compass a vast number of most interesting facts respecting the means by which plants protect themselves against animals and unfavorable weather. He has also presented the results of some

studies in regard to the relations of plants to salt water, noting particularly the difference in habit between maritime plants and those of the interior. After this follow some unfinished geological speculations.

Botanical Directory. — We call attention to the following notice by Mr. Leggett: "In view of the great utility to botanists of a full and correct directory, your aid is invited to render the new edition as complete as possible. It should include all botanical workers in America in every department; also libraries and herbaria valuable as references for their extent or special riches; also botanical societies and gardens. Specialties and a desire to exchange should be noted. It is hoped to issue the work about December 1st. The price will be for a single copy 40 cents; three copies for $1.00; a dozen for $3.00. Address Wm. H. Leggett, 54 East 81st Street, New York."

Scientific German. — Under this title a work has been prepared by Mr. H. B. Hodges, instructor in chemistry and German in Harvard University. It is designed to aid students in acquiring a practical knowledge of the words, phrases, and general style of German writers upon scientific subjects. The portions of the work devoted to botany are very valuable. First are given lessons on histology, morphology, and physiology; after which follow selections from recent works by well-known authors. Of those most interesting to our botanical readers we will mention: Grisebach, On the Influence of Forests upon Climate; Liebig, On the Origin of Arable Soil, and Humus; Sachs, On Movements of Plants. The volume exhibits great painstaking, and excellent judgment throughout. The vocabulary is copious and accurate, and will prove of great use to readers of the recent German works on botany.

Catalogue of Wisconsin Plants. — Th. A. Bruhin, of Centreville, Wis., communicates (date of April, 1876) to the Zoological and Botanical Society of Vienna a list of the plants of his State. The catalogue is prefaced by three shorter lists: first, the names of plants supposed to be common originally to the flora of Europe and Wisconsin. Of the 239 species, 122 are dicotyledons, 85 are monocotyledons, the remaining 32 are vascular cryptogams. The second list comprises the plants carried from America to Europe and now growing wild there, and some of those more frequently cultivated, together 35 species. In the third list are the 176 European plants introduced into Wisconsin. From these lists we learn that 450 species are common to Wisconsin and Europe.

The Size of the Leaves of Austrian Woody Plants. — In this memoir, Dr. Pokorny presents what he calls a phyllometric method, and which he believes is applicable to many leaves of shrubs and trees. He describes three transverse axes which cross the median line at right angles. The first of these is distant from the base of the leaf blade one fourth the length of the leaf; the second divides the leaf into halves; the third is midway between this line and the apex of the leaf. The ratios existing between these axes should give exactness to the terms applied

to the forms of leaves. That our readers may make the attempt to utilize these ratios, we here transcribe the set given in the diagrams.

The longitudinal axis is assumed to be in all cases 100. say millimetres, or any units of measurement.

The first transverse axis, that which cuts the longitudinal midway between the base of the leaf and its middle point, is called B_1; the second, at the middle, is B_2; the third, midway between this and the apex, is B_3.

B_3 8.6	B_3 5.	B_3 5.
B_2 10.	B_2 10.	B_2 10.
B_1 8.6	B_1 5.	B_1 8.6
Elliptical,	Rhombic,	Ovate.
B_3 8.6	B_3 3.3	B_3 2.5
B_2 10.	B_2 6.7	B_2 5.
B_1 5.	B_1 10.	B_1 7.5
Obovate,	Deltoid,	Triangular.

The different woody plants of Austria have been studied by Dr Pokorny with respect to the ratios of these axes in the leaves, and the results are given in detail in the twenty-seventh volume of the Transactions of the Zoölogical and Botanical Society at Vienna.[1]

Botanical Papers in Recent Periodicals. — *Botanical Gazette.* September. Dr. J. T. Rothrock, On Poisonous Properties of Leguminosæ. (Elsewhere noticed.) Professor Lockwood, Shipping Live Plants. (The plants were *Nymphœa lutea* and *odorata, Helonias bullata, Erythronium Americanum, Claytonia Virginica, Thalictrum anemonoides, Pyxidanthera barbulata*, and an amaryllis. The roots of these plants were surrounded by moist plastic clay, and then securely packed in a cask with sand. They were shipped on May 9th, and were received at Sydney, Australia, late in June. The *Pyxidanthera* was dead, but the species of Nymphæa were in good condition, and all the rest alive.) G. E. Davenport, Vitality in Ferns. (A plant of *Polypodium vulgare* was kept in a warm room in a perfectly dry state from November, 1876, until April, 1877. "It had become so dry and shriveled that it did not seem possible for any life to exist; yet under the influence of frequent rains it soon began to start, and is now (August 3) growing moderately.") Several notes respecting collections in Southwestern Virginia and in Missouri are given by Messrs. Shriver, James, and Barnes.

Trimen's Journal of Botany. September. H. Trimen, On *Lavatera sylvestris*, in Britain. J. G. Baker, On Brazilian Species of Alstromeria. G. S. Jenman, Ferns new to Grisebach's Flora of the West Indies. H. F. Hance, On Intoxicating Grasses. (Elsewhere noticed.) H. F. Hance, *Thorelia*, a New Genus of Lythraceæ. Baron von Mueller, List

[1] Verhandlungen der Kaiserlich-Königlichen Zoölogisch-Botanischen Gesellschaft in Wien, 1877.

of Mr. Gile's Australian Plants. Three excellent abstracts of German memoirs are given.

Botanische Zeitung, No. 32. Dr. Harz, On the Origin and Properties of Spergulin (a new fluorescent from the seed-coats of *Spergula vulgaris*). Continued from the last number. Reports of Societies. No. 33. B. Ascheron, Phytographic Notes. Christoph Gobi, On Some Phæosporeæ of the Baltic. No. 34. H. G. Holle, On the Point of Growth in the Roots of Dicotyledons. No. 35. A. Morgen, On the Process of Assimilation in germinating Cress (*Lepidium sativum.*) Continued in Nos. 36 and 37. In No. 37 there is a paper by Dr. O. Drude, On the Structure and Systematic Position of the Genus *Carludovica.* The genus is assigned a place between *Pandanaceæ* and *Palmeæ*. No. 38. Dr. O. Drude, Selected Examples to explain the Formation of the Fruit in Palms. Rostafinske, of Cracow, A Reply to Certain Criticisms by Reinke.

ZOÖLOGY.[1]

Destruction of Birds by Telegraph Wires. — Referring to Dr. Coues's article on this subject, in the Naturalist and elsewhere, I wish to add my testimony to the destruction of much larger birds than any mentioned by this writer. Many prairie chickens (*Cupiaonia cupido*) are annually destroyed in this way. In December, 1868, near Cambridge, Story County, Iowa, I saw many of these birds lying dead on the snow, beneath the line of the telegraph, and was informed by the stage driver that they killed themselves by striking the wire in their rapid flight. Some of the birds had their heads cleanly cut off, and most of them were torn and lacerated to a greater or less extent. One or two of the wounded were still alive and fluttering. The spot seemed to be a favorite one for the flight of the chickens. A high belt of timber skirted the river, and beyond this lay the mile-wide expanse of "Skunk Bottom," bounded by high bluffs on the east. For certain reasons — possibly owing to some peculiarity of the winds at this point, or to the protection afforded by the belt of timber — the birds were accustomed to speed like arrows down across this bottom, and slight contact with the single wire that stretched across would either maim or kill them outright. Since that time I have heard of several instances in which these birds have been killed in the same manner. The destruction of these birds is so general along some of the railroad lines in the West that section men make a regular business of gathering them up as an addition to their own stock of provisions. The telegraph wires may therefore be set down as one of the means — and not an insignificant one — whereby the extermination of the prairie hens is proceeding with a degree of rapidity which would be astonishing had we any means of mak-

[1] The departments of Ornithology and Mammalogy are conducted by Dr. Elliott Coues, U. S. A.

ing even an approximate calculation. — CHARLES ALDRICH, Webster City, Iowa.

FOOD OF THE SKUNK. — In his recently published most admirable monograph on the North American Mustelidæ, Dr. Elliott Coues, writing of the "common skunk" (*Mephitis mephiticus*), says, "They feed largely upon insects, birds, eggs, such small reptiles as frogs, small quadrupeds, such as the various kinds of mice," and adds; that "they are also said to capture rabbits in the burrows in which the timorous beasts sometimes take refuge, though they are manifestly incapable of securing these swift-footed animals in the chase." He likewise refers to the well-known fact of their depredations on poultry-yards. Some years ago I shot one of these animals near the celebrated "Walled Lake," in Wright County, Iowa, at the entrance of a burrow where it would seem that they had lived and multiplied and half-hibernated during many generations, for their excrements formed quite a mound around the entrance of their habitation. This refuse was composed almost wholly of the hinder portions of the craw-fish, which swarmed in the sloughs and ponds of the surrounding prairie. The animal matter had of course disappeared in the process of digestion, and the accumulations had bleached out so as to look like a heap of lime, — as it really was, — in every part of which were fragments of the limbs and external parts of these craw-fish of the prairie. The heap was so large that it at once suggested the idea that it must have been deposited by larger animals; but some portions were quite recent, while the hole was too small to admit any of our larger prairie mammals, such as the wolf, fox, or badger Hence I concluded that the craw-fish formed a staple portion of the food of this "*enfant du diable*," as the old French naturalist termed it before science had given it so many names. — CHARLES ALDRICH.

TENACITY OF LIFE SHOWN BY SOME MARINE MOLLUSKS. — In 1875 I collected on several of the Florida keys *Littorina muricata* L. in quantities. This was in February. I brought home quite a number alive and put them in my barn, intending to let the animals die and the shells lose their odoriferous qualities before transferring them to my collection. What was my surprise to find the animals still alive in April, two months after they were collected. They had not been exposed to moisture during the time. The last of them died in May. Again, only last winter, I collected at St. Augustine, Florida, *Littorina irrorata* Say, putting them in tin cans and boxes which in due course of time arrived home. On the first of May last I emptied the shells in a sunny place, and the animals within quickly crawled out. This was four months after I secured them. I have in my collection many Helices that have remained alive shut up in boxes for over three years, — a thing that did not surprise me, as numerous similar instances are on record; but I never before knew marine or semi-marine species to show so much tenacity of life when removed from their natural situations. — W. W. CALKINS.

Note on the Mexican Spermophilus. — Fresh specimens of this animal (*S. Mexicanus*), still rare in collections, have reached me through Mr. George B. Sennett, of Erie, Pennsylvania, who has lately returned with a fine collection of mammals and birds from the vicinity of Fort Brown, Texas, — a highly interesting locality, which, through the exertions of Dr. J. C. Newell, of the army, and of Mr. Sennett, has furnished various species new to our fauna. In 1857 Professor Baird had some dozen or more specimens to work upon, but no additional ones have hitherto been forthcoming, as Mr. Allen's monograph just published catalogues none. Mr. Sennett's specimens are in fine order, and correspond precisely with Baird's and with Allen's elaborate descriptions. — Elliott Coues, Washington, D. C.

Papilio Cresphontes in New England. — On the 6th of last September, Mr. N. Coleman captured in the vicinity of Berlin, Connecticut, the only specimen of this Southern insect ever recorded from New England. As the larva is not known to feed on any other plant than the orange, the butterfly probably hatched from a larva accidentally transported with trees from Florida, or emerged from a chrysalis sent North as a curiosity.

ANTHROPOLOGY.

Examinations of Indian Mounds on Rock River, at Sterling, Illinois. — I recently made an examination of a few of the many Indian mounds found on Rock River, about two miles above Sterling, Illinois. The first one opened was an oval mound about twenty feet long, twelve feet wide, and seven feet high. In the interior of this I found a *dolmen* or quadrilateral wall about ten feet long, four feet high, and four and a half feet wide. It had been built of lime-rock from a quarry near by, and was covered with large, flat stones. No mortar or cement had been used. The whole structure rested on the surface of the natural soil, the interior of which had been scooped out to enlarge the chamber. Inside of the dolmen I found the partly decayed remains of eight human skeletons, two very large teeth of an unknown animal, two fossils, one of which is not found in this place, and a plummet. One of the long bones had been splintered; the fragments had united, but there remained large morbid growths of bone (exostosis) in several places. One of the skulls presented a circular opening about the size of a silver dime. This perforation had been made during life, for the edges had commenced to cicatrize.

I later examined three circular mounds, but in them I found no dolmens. The first mound contained three adult human skeletons, a few fragments of the skeleton of a child, the lower maxillary of which indicated it to be about six years old. I also found claws of some carnivorous animal. The surface of the soil had been scooped out, and the bodies

laid in the excavation and covered with about one foot of earth; fires had then been made upon the grave, and the mound afterwards completed. The bones had not been charred. No charcoal was found among the bones, but occurred in abundance in a stratum about one foot above them. Two other mounds examined at the same time contained no remains.

Of two other mounds opened later, the first was circular, about four feet high, and fifteen feet in diameter at the base, and was situated on an elevated point of land close to the bank of the river. From the top of this mound one might view the country for many miles in almost any direction. On its summit was an oval altar, six feet long and four and one half wide. It was composed of flat pieces of limestone, which had been burned red, some portions having been almost converted into lime. On and about this altar I found abundance of charcoal. At the sides of the altar were fragments of human bones, some of which had been charred. It was covered by a natural growth of vegetable mold and sod, the thickness of which was about ten inches. Large trees had once grown in this vegetable mold, but their stumps were so decayed I could not tell with certainty to what species they belonged. Another large mound was opened which contained nothing. — W. C. HOLBROOK.

CHRISTENING CEREMONY OF THE SEMINOLE INDIANS. — The Seminole Indians, now inhabiting the Indian Territory, were formerly in the habit of performing the following ceremony at the christening of their male children: At about the age of fourteen the boy was scratched or incised, with a sharp flint, six times on each arm and leg, the length of the incisions being about a foot. If the subject flinched or cried out, he was given an insignificant name, and was not considered worthy to be a warrior; but if he bore the operation manfully he was given a high-sounding title, and was destined to become a great man in the tribe. — E. A. BARBER.

MAN IN THE PLIOCENE IN AMERICA. — The evidence, as it stands to-day, although not conclusive, seems to place the first appearance of man in this country in the Pliocene, and the best proof of this has been found on the Pacific coast. During several visits to that region, many facts were brought to my knowledge which render this more than probable. Man at this time was a savage, and was doubtless forced by the great volcanic outbreaks to continue his migration. This was at first to the south, since mountain chains were barriers on the east. As the native horses of America were now all extinct, and as the early man did not bring the Old World animal with him, his migrations were slow. I believe, moreover, that his slow progress towards civilization was in no small degree due to this same cause, the absence of the horse.

It is far from my intention to add to the many theories extant in regard to the early civilizations in this country, and their connection with the primitive inhabitants, or the later Indians; but two or three facts have

recently come to my knowledge which I think worth mentioning in this connection. On the Columbia River, I have found evidence of the former existence of inhabitants much superior to the Indians at present there, and of which no tradition remains. Among many stone carvings which I saw there, were a number of heads which so strongly resemble those of apes that the likeness at once suggests itself. Whence came these sculptures, and by whom were they made? Another fact that has interested me very much is the strong resemblance between the skulls of the typical mound-builders of the Mississippi Valley and those of the Pueblo Indians. I had long been familiar with the former, and when I recently saw the latter, it required the positive assurance of a friend who had himself collected them in New Mexico to convince me that they were not from the mounds. A third fact, and I leave man to the archæologists, on whose province I am even now trenching. In a large collection of mound-builders' pottery, — over a thousand specimens, — which I have recently examined with some care, I found many pieces of elaborate workmanship so nearly like the ancient water-jars from Peru that no one could fairly doubt that some intercourse had taken place between the widely separated people that made them.

The oldest known remains of man on this continent differ in no important characters from the bones of the typical Indian, although in some minor details they indicate a much more primitive race. These early remains, some of which are true fossils, resemble much more closely the corresponding parts of the highest Old World apes than do the latter our Tertiary primates, or even the recent American monkeys. Various living and fossil forms of Old World primates fill up essentially the latter gap. The lesser gap between the primitive man of America and the anthropoid apes is partially closed by still lower forms of men, and doubtless also by higher apes, now extinct. Analogy, and many facts as well, indicates that this gap was smaller in the past. It certainly is becoming wider now with every generation, for the lowest races of men will soon become extinct, like the Tasmanians, and the highest apes cannot long survive. Hence the intermediate forms of the past, if any there were, become of still greater importance. For such missing links, we must look to the caves and later Tertiary of Africa, which I regard as now the most promising field for exploration in the Old World. — Professor Marsh's Address at Nashville as Vice President of the American Association.

ANTHROPOLOGICAL NEWS. — The Rev. S. D. Peet, of Ashtabula, Ohio, has assumed the editorship of the *American Antiquarian*, a quarterly journal of correspondence on American archæology, ethnology, and anthropology; price $2.00 per annum. We have announced by the same gentleman A Manual of Archæology; being a Complete Analysis and Compendium of the Science, designed especially for Beginners.

The *Journal of the Anthropological Institute* announces for the August number the ollowing pape frs of general interest: Primitive Agriculture, A. W. Buckland; Non-Sepulchral Rude Stone Monuments, M. T. Walhouse; The Himalayan Origin of the Magyars, Hyde Clarke; The Brain Weight of some Chinese and Pelew Islanders, Dr. Crochley Clapham; Right-Handedness, James Shaw; The Mental Progress of Animals during the Human Period, James Shaw.

During the meeting of the British Association in Plymouth, excursions were made to Totnes, Torquay, and Brixham caves. The opening address before the geological section, by Mr. Pengelly, was an elaborate report of the exploration of caves in the vicinity of Plymouth, including the Orestin caverns, Kent's Hole, Yealm Bridge caverns, the Ash Hole, Brixham Cavern, Windmill Hell, and Ansty's Cave. The following papers were among those read before the anthropological department: Francis Galton, On a More Accurate and Extensive Method of Observations on those Groups of Men who are sufficiently Similar in their Mental Characters or in their Physiognomy, or in Both, to admit of Classification; Dr. Beddoe, On the Bulgarians; Dr. Phéné, On the District of Mycenæ, and its Early Inhabitants; Park Harrison, On Characters found in the Sides of the Tunnels driven into the Chalk of Sussex; Mr. Sorby, On the Coloring Matter of the Human Hair; Miss A. W. Buckland, Ethnological Hints afforded by the Stimulants of Ancient and Modern Savages; Mr. A. Simpson, Who are the Zaparoz, a Tribe of Ecuador; Mr. Hunter, On the Natives of Socotra; B. Hartshorne, Ancient People and Irrigation Works in India; Professor Rolleston, On the Rationale of Brachycephaly and Dolicocephaly; Artificial Deformation of the Head; The Fauna and Flora of Prehistoric Times. There were about thirty papers read before this department.

The American Association had such a poor showing of anthropologists on the first day that the subsection was merged into the section of biology. The members came in a little later, and Monday, August 31st, was assigned to them. The opening address of the president, Dr. Daniel Wilson, of Toronto, was partly a *résumé* of anthropological science, and partly an invitation to cultivate the speaker's peculiar field, namely, the ethnological problems that are being worked out on the American continent by the mingling of many races under various climatic and social conditions. Among the papers read are the following: The American Indians of North America, Henry C. Carrington; All Life conditionally Immortal, William Bross; Additional Facts concerning Artificial Perforations of the Cranium in Ancient Mounds in Michigan, Henry Gilman; Introduction to the Study of Indian Languages, J. W. Powell; Report on the Exploration of the Graves of the Mound Builders in Scott and Mississippi Counties, Missouri; Some Observations on the Skull of the Comanches, T. O. Summers. Colonel Garrick Mallery read a very elaborate paper on the probability that

there has been no diminution in the number of the Indians of the North American continent since the first settlement. The author took the ground that the works which are supposed to have taken great numbers to accomplish them were rather the results of long-continued labor. This statement in opposition to the almost unanimous opinion of writers on our Indians was the subject of considerable attention. Professor Marsh in his address before the section of biology took occasion to say that while the primates originated on the American continent, the absence of higher fossil forms argues their subsequent migration, and consequently the impossibility of man's having originated in our hemisphere.

The Davenport (Iowa) Academy of Natural Science has issued volume ii. part i. of its Proceedings. Among the valuable contributions to archæology, the one which will attract the most attention is the description, by the Rev. J. Gass, of his discovering in a mound tablets of soft shale, having elaborate inscriptions scratched on them. One represents a hunting party, another a cremation scene, and a third is a supposed calendar.

In addition to the antiquities already mentioned from Porto Rico and described in the Smithsonian Report for 1876, Professor Baird has just received from Mr. Lewis Jones R. Brace, of Nassau, N. P., drawings of celts, images, and stools, differing from those already described only in detail. Among the specimens are two wooden stools, one of which is the long-tailed variety sent by Messrs. Gabb and Frith. The other is a short-tailed variety, and resembles very much a shallow dish. I have seen similarly shaped, so-called mortars or metates from Central America, made to resemble a quadruped, the head projecting in front and the tail twisted around for a handle.

The Smithsonian Annual Report for 1876, just published, is in some respects the most interesting number ever issued.

Dr. Paul Broca, the distinguished anthropologist, presided over the French Association this year. In his opening address he gave a *résumé* of the fossil races of Western Europe, dividing them as follows: —

1. Canstadt Race, the oldest (dolicocephalic).
2. Cromagnon Race (").
3. Furfooz Race (brachycephalic).

Authors of anthropological treatises and papers, desiring to have them noticed in Baird's Annual Record, will please send copies to Professor S. F. Baird or to O. T. Mason, Washington, D. C. — O. T. Mason.

GEOLOGY AND PALÆONTOLOGY.

Discovery of Jointed Limbs in Trilobites. — In a paper entitled Notes on Some Sections of Trilobites from the Trenton Limestone, published in advance of the report of the New York State Museum of Natural History, Mr. C. D. Walcott describes and figures jointed limbs in

Calymene and Ceraurus. It will be remembered that the nature of the limbs of trilobites has been long a matter of controversy, some believing they had soft, membranous limbs, and others that they had jointed limbs, like those of the king crab (Limulus) and the fossil Eurypterus, etc., and still others that they may have had anterior ambulatory jointed limbs, and posterior broad membranous swimming abdominal appendages. Mr. Walcott, after making many sections of trilobites, has discovered jointed appendages in them, numerous sections of *Calymene senaria* showing axial appendages with three joints; "the third joint in all appendages of this species seen (seventy-seven in number) terminates in a round, blunt end." In *Ceraurus pleurexanthemus* the limb is five jointed. The legs end in a single blunt end, and Mr. Walcott is inclined to think the legs will be found to have "five or six joints with a terminal claw."

"Attached to the basal (?) joint of the leg there is a slender-jointed arm of two, and probably three joints. Portions of pinnulæ are attached to the terminal joint. Whether they are branchial tubes cannot be satisfactorily determined from the section. In other sections rows of pinnulæ are shown which are undoubtedly branchial tubes. From the character of the remaining portion of the respiratory apparatus they must have been attached to the arm. It is also quite probable that a branchia was attached to the basal joint of the arm. It may be that its occurrence in this position in the section, is owing to a displacement of one of the branchiæ attached to the side of the thoracic cavity. These branchiæ are attached above the basal joint of the leg. The branchia in *Calymene senaria* projects out a short distance and then bifurcates, sending two spirals nearly to the edge of the dorsal shell. In some sections the base appears to be a portion of the ribbon or band forming the spiral straightened out, while in others it is a closely coiled spiral. At the bifurcation the outer spiral springs from the base which continues on to form the inner spiral."

A transverse section of the head of Calymene cut so as to cross the hypostoma just within the posterior end, exhibited a space filled with calc-spar, which "is the continuation of the visceral cavity of the thorax." From the lower lateral margin of each side a jointed appendage extends outward and downward. "Between the upper pair of appendages and the glabella three pairs of appendages project. Their basal joint is slender, and, in two sections, closely resembles the maxillary joint of the leg of the Eurypterus, modified in form, but undoubtedly subservient to the same use as a part of the mouth." Sections of *Asaphus platycephalus* furnish evidence that it had axial appendages of essentially the same structure as those of Calymene and Ceraurus.

Mr. Walcott concludes that the homology between the parts about the mouth of the trilobite and the same organs in the *Eurypterida* and *Xiphosura* is very direct and relates the families closely, and he considers that the *Xiphosura*, *Eurypterida*, and *Trilobita* form the legion Me-

rostomata and subclass Gnathopoda. Having ourselves, from a study of the king crab and the tegument of the trilobites, and from the suggestions of Billings regarding the nature of the appendages of the trilobites, arrived at the conclusion that the trilobites most probably had jointed ambulatory limbs as well as membranous swimming appendages, it is gratifying to find what was before a matter of probability, actually demonstrated by the patient toil and well sustained energy of Mr. Walcott.

The discovery of the nature of the limbs of trilobites "adds a fresh laurel," to use a fossilized expression, to American palæontology.

THE GREENLAND GLACIERS. — Amund Helland, of Christiania, Norway, made in 1875 a journey to North Greenland, and gives in the *Quarterly Journal of the Geological Society of London* (No. 129), the results of his comparisons of the glacial phenomena of that country with those of Norway. He has overlooked the writings of Americans who have visited Greenland, and he probably never saw the magnificent work in folio of our marine artist, William Bradford of New York, which contains many photographs of the Greenland glaciers, and possesses a good deal of scientific value. Helland believes that "the thickness of the inland ice near its border cannot exceed 250 metres, and is probably not more or is even less than 200 metres; but since its surface rises as we proceed inland, its thickness may possibly increase in that direction."

"The amount of precipitation in North Greenland seems to indicate indirectly the great extent of the inland ice; for where the glaciers are largest it is not considerable; at the colony of Jakobshavn the rainfall from July, 1873, to July, 1874, was 219.7 mm., from July, 1874, to July, 1875, 183.7 mm. In the district of Umanak, where there are a number of great ice-fjords, the rainfall seems to be no greater; yet here the glaciers are very large, one may say the largest known; so that we can only account for them by supposing that they are supplied from a very extensive upland district on which there is a considerable snow fall, and thus that there can be little land in the interior free from ice. Be this as it may, there is no doubt that the ice-sheet extends into Greenland beyond the range of vision."

The fact, he says, that though the climate of Greenland is rather dry large glaciers are numerous, is not without geological importance, as showing that a great snow fall is not absolutely necessary for the glaciation of an extensive country. "It is also remarkable that the glaciers are supplied from an ice-field which, to a large extent at least, lies below the limit of perpetual snow." He contends that Greenland is not a collection of islands, but a fjord land like Norway or the coast of North America.

He found that the Jakobshovn glacier flows with a velocity greater than any that has hitherto been observed, the greatest daily motion observed being 22.46 metres, from July 8th, seven P. M., to July 9th, ten A. M., while the slope of the land is only half a degree. The maximum daily

motion as observed by Professor Tyndall on the Mer de Glace (Chamouni) was $33\frac{3}{4}$ inches (0.85 metre) in June.

"The rate of flow, already mentioned, has an important bearing on the theory of glacier-motion. As the slope of the Jakobshavn glacier, which has the extraordinarily rapid motion of twenty metres *per diem*, is only half a degree, the fall of the bed of the valley cannot be the most important factor in the motion of glaciers. This considerable velocity must be due to the quantity of ice which has to be carried out to the fjord; or, in other words, the rate of motion is dependent on the pressure of the mass of the inland ice. Glaciers, therefore, fed from large districts of atmospheric precipitation, move with considerable velocity."

Helland thinks it doubtful if the ice-sheet and the glaciers would form again could the land be denuded of them and left to the influences of the present climate.

The author also discusses in an interesting way the formation of cirques and lake basins in Norway and Greenland, but the views of Ramsay and others which he supports are becoming antiquated.

GEOGRAPHY AND EXPLORATION.

Stanley's Journey across Africa. — Following the journey of Cameron across the continent of Africa from coast to coast, we have the adventurous march of Stanley, who arrived at Loanda, on the west coast, August 21st. From a *résumé* in the *Nation* we learn that he began his journey in November, 1874, at Bagamoyo, on the east coast. He was a year and a half reaching Ujiji, but meanwhile had surveyed the Victoria Nyanza, had crossed the intervening divide to the Albert Nyanza, and had explored the Alexandra Nile. He next, after visiting Lake Tanganyika, followed up the Lukuga, which Cameron had considered a genuine outlet to the lake, but which Stanley claimed was only such in exceptionally high water. In November, 1876, he set out through Uregga, crossed the left bank of the Lualaba, and passed around a series of cataracts, situated just north and south of the equator. "At 2° N. latitude the northerly course of the river bends to the northwest, then to the west, and finally to southwest, where its width is from two to ten miles, and the stream is choked with islands." This river was called Congo by the natives. On the 8th of August, 1877, Stanley arrived at Boma, at the head of the Congo delta; on the 14th, at Cabinda, on the coast; and on the 21st at S. Paulo de Loanda. "His party (114 in number) was greatly reduced by dysentery, scurvy, and ulcers, and his last white comrade, Francis Pocock, had perished by being carried over one of the cataracts. His faithful body-servant, Kalulu, was also among the missing. The importance of Stanley's discoveries, in a geographical point of view, cannot be overestimated. They take rank among the foremost of the century, and are destined to give a new impulse and direction to exploration in Central Africa. Hitherto geographers had not conjectured that

the course of the Congo approached the equator, but it is now evident that the river can be reached by a short cut from the Albert Nyanza, or from Schweinfurth's river Welle. This stream, if it should not prove a tributary of the Congo, may not impossibly be the upper portion of the Ogove, the last great river on the West African coast whose origin is a mystery."

GEOGRAPHICAL NEWS. — A new interest in Arctic Exploration has been excited in this country by the departure of Captain Howgate's vessel, Florence, for Cumberland Island, the first stopping-place on the way to Smith's Sound. The *Geographical Magazine* is urging the continuance and completion of polar discovery on the part of the English government, and says that four routes now remain for future expeditions. (1.) The Jones Sound route, the work of which will be to connect North Lincoln with Aldrich's farthest, and to ascertain the limits of the Palæocrystic sea in that direction. (2.) The East Greenland route, to connect Cape Bismarck with Beaumont's farthest, and so complete the discovery of Greenland. (3.) The route of Franz Josef Land, to explore the northern side of the country discovered by Payer; and (4) the Northeast Passage, by which a knowledge of the sea north of Siberia will be completed, and Wrangell Land will be explored. On the whole the editor suggests that the East Greenland route is the best that can be selected for a new expedition. Lieutenant Weyprecht, who commanded the Austrian Polar Expedition that discovered Franz Josef Land in 1874, and Count Wilczek, one of the promoters of that expedition, have announced to the Royal Society of Meteorology of Utrecht that they intend to undertake an expedition to the Arctic regions, which will be away for about twelve months, and that they intend to establish their station of observation in one of the northern havens of Novaya Zemlya. A translation of Dr. Rink's Danish Greenland, its People and its Products, the standard work on Greenland, has been published by H. S. King & Co., London, and is a very timely work.

Several books on Turkey have appeared in London: Turkey in Europe. By James Baker. Third edition (Cassell, Petter, & Galpin, London, Paris, and New York), 1877. Travels in the Slavonic Provinces of Turkey in Europe. By G. Muir Mackenzie and A. P. Irby, with a preface by the Right Hon. W. E. Gladstone, M. P. In two volumes, second edition (London: Daldy, Isbister, & Co.), 1877. Montenegro, its People and their History. By the Rev. W. Denton, M. A. (London: Daldy, Isbister, & Co.), 1877. Handbook of the Seat of War. Edited by Alexander Mackay (London: Simkin, Marshall, & Co.), 1877.

The preservation of forests in New Zealand is attracting attention, as the colonists, by indiscriminate waste of trees, are threatening future disaster to the water supply, agriculture, and the health of the people. It appears that Frnce has suffered cruelly from the effects of a long course of denudation, and is now trying energetically to retrieve the errors of the

past. The same may be said of the United States, though increased attention has lately been paid to the planting of new and the preservation of old forests.

MICROSCOPY.[1]

The New Mechanical Fingers. — Several new devices for picking up and arranging diatoms, Polycystina, and other small objects have recently been described, the chief peculiarity of which consist in supporting the object from the substage, while the instrument is supported from and moved by the stage which usually bears the object-slide. By unaccountable oversight it was not stated that this expedient was the chief peculiarity of Mr. Zentmayer's mechanical finger, which was contrived in 1869, published in different journals early in the following year, and advertised and sold as a regular article of manufacture ever since. In the May number, 1870, of the *Journal of the Franklin Institute*, a cut is given of Zentmayer's invention, in which the finger is fastened to a pillar clamped to the upper plate of the mechanical stage of the microscope, while the substage is prolonged through the opening of the stage for the purpose of supporting the object. In the accompanying description Mr. Zentmayer explains that it was his object to utilize such movements of a first-class stand as were not essential for other operations connected with the use of the finger; that by attaching his apparatus to the mechanical stage he obtained sliding horizontal movements with a firmness and range not otherwise attainable; and that for the low powers employed a plain stage supported from the substage, and projecting slightly above the stage, was all that was required for holding the object and would give the necessary vertical movement to it. Mr. Zentmayer makes a special accessory to the substage for carrying the object, and a vertical adjustment to the finger itself; while subsequent experimenters have supported the object on the paraboloid or some other piece of common apparatus, and have simplified the finger by dispensing with a vertical adjustment, in both cases saving complication and expense at some loss of efficiency.

A Modification of Wenham's Reflex Illuminator. — The very ingenious and interesting reflex illuminator of Mr. Wenham was designed to avoid direct illumination by passing light into the slide at such an angle that it would be totally reflected instead of passing into air above the slide. With dry objectives, of any angle, this illumination would necessarily be exclusively reflex, since no light could pass directly to the objective; and with immersion objectives of angular aperture not greater than that corresponding to one hundred and eighty degrees dry, the result would be practically the same, as the light, after passing through a balsam-mounted object, would reach the lens at an obliquity greater than that of its extreme capacity for image-forming rays. But

[1] Conducted by Dr. R. H. Ward, Troy, N. Y.

for lenses of greater angle than this, the illumination would be direct, the image being formed exclusively by that portion of the available aperture of the lens which was in excess of the equivalent of one hundred and eighty degrees dry angle. The existence, and even the possibility, of such lenses was not at that time undisputed, some eminent microscopists still maintaining the contrary opinion. But the new reflex illuminator had scarcely arrived in this country before Mr. Samuel Wells, of Boston, succeeded in making it act as a direct illuminator, with several lenses of at least two makers, an efficient and excellent image being formed by these extralimital rays. It immediately occurred to Mr. Tolles that a similarly good illumination might be obtained in the case of dry lenses, and immersion lenses of moderate angle, by changing the angle of the reflecting face so that the illuminating pencil should fall just without instead of just within the angle of total reflection. He at once made several such prisms, of various angles, but, hoping to improve still further upon the plan, refused to offer them for sale. One of these was presented by Dr. R. H. Ward at the Nashville meeting of the American Association this summer. Its reflecting face was inclined twenty-one degrees to the axis, giving an obliquity of forty-two degrees to the central reflected ray. This utilizes the extreme angle of an objective close up to one hundred and eighty degrees dry, or its equivalent in balsam, and in addition gives a slight illumination, though by itself insufficient for useful work, of extralimital rays available exclusively to immersion lenses of excessive aperture. With suitable lenses it gives prompt resolution of numbers eighteen, nineteen, and twenty of Moller's test plate in balsam, by lamp-light. The modified prisms are inferior to the original for use with lenses capable of taking up half the pencil transmitted into balsam by the original "reflex." The prism of twenty-one degrees gives the maximum efficiency with dry mounts, as the extreme capacity of the lens is utilized by the half pencil from the illuminator, which can be transmitted to it, — a condition very favorable for difficult resolution. Prisms of still smaller angles were made, and are now used for lenses of lower angle. The length of prism, and the condensing arrangement, are modified to suit the changed angle. As in the original reflex, the chromatic aberration is excessive; and it is a question how far the very decided results in resolution attained are due to the nearly perfect monochromatic illumination thus secured. The new illuminators do not seem to have given results not otherwise attainable, and they are subject to the inconvenience that each one is limited to a fixed and comparatively narrow range of angles; but they furnish a ready and easy means of oblique illumination, suitable for extremely difficult resolution, and entirely independent of thinness of stage and concentric rotation of object-carrier.

MICROSCOPIST'S ANNUAL. — The Industrial Publication Company, of 176 Broadway, New York, having undertaken to publish a list of the

prominent makers, importers, and sellers of microscopes, has extended the scope of the work to other items of interest to microscopists, and will include in the publication, to be issued annually, various tables and data, and a list of microscopical societies, their officers, etc., after the model of that originally published in the NATURALIST. The price of this convenient little work is 25 cents. Persons interested are requested to send subscriptions and data to the above address.

EXCHANGES. — Rare chemicals for the polariscope, starches, etc., offered for well-mounted slides; anatomical preparations preferred. Exchange lists printed for microscopists by papyrograph. Address G. E. Bailey, Lincoln, Nebraska.

Plumule scales of small cabbage butterfly (*Pieris rapæ*), mounted, for good slides. Address Edward Pennock, 805 Franklin Street, Philadelphia.

Shell sand from Bermuda containing very fine foraminifera, spicules, etc., either mounted or unmounted. Address C. C. Merriman, Rochester, N. Y.

SCIENTIFIC NEWS.

— A special meeting of the California Academy of Sciences was held August 31st, for the purpose of extending a formal welcome to a trio of distinguished scientists then visiting the State, namely, Sir J. D. Hooker, C. B., Prof. Asa Gray, and Prof. F. V. Hayden. After eloquent addresses of welcome by the president of the Academy, Professor Davidson, and by Messrs. Henry Edwards and R. E. C. Stearns, Sir J. D. Hooker returned thanks for the cordial welcome given, and said he came here to learn, and not to teach, and his visit was immediately due to the experience of his old friend, Professor Gray — a friend of forty years' standing — and to the invitation of his old correspondent, Professor Hayden, whose guests they had been during the time they spent in Colorado and Utah. His acquaintance with the vegetation of America had heretofore been an extremely slight one. In association with his father's pursuits, who was for many years occupied in publishing investigations of the plants of the British possessions of North America, he was led to the investigation of the Arctic flora. In the investigation he was struck with the uniformity of vegetation extending round the whole globe in the North. There was very little difference between the vegetation of America and the Old World within the Arctic circle; but upon close examination he found that even the American flora was divisible into two sections by very slight but still definite characters; that in crossing over from Greenland to the American islands, so called, there was a distinct change in the vegetation, though very slight. The opportunity he had now had of crossing the continent of North America from east to west, had shown him that that distinction is carried out to a very much greater

extent than he had any notion of. The publications of Gray and others, had made him aware that there is a broad line of distinction between the vegetation east of the Mississippi and west of it, but he did not expect to find the variety so great as it is, and he was strongly inclined to say, though he said it under correction, that there is probably a greater difference between the east and west coasts of the American continent than there is between any two similarly related regions in any part of the globe; that you may travel from England to Spain, from Siam to China, without finding so diverse vegetations as by crossing the Mississippi and comparing the banks one hundred miles east on one side with one hundred miles west on the other. As far as the country east of the Mississippi is concerned, he was, by practical observation, almost entirely ignorant. He knew nothing of it except from the copious notes of Professor Gray conned while traveling. Since then he had the opportunity of spending some weeks in the Rocky Mountains and then of coming here, and he found a more curious difference than he had anticipated in the vegetation between the Rocky Mountains and the Sierra Nevada. He had every reason to suppose that this great difference of vegetation exists south of the parallel along which he had traveled. Time had not allowed them to digest the notes collected on the way, and more than he had announced he was not prepared to say. The president had asked him to say a few words with respect to the Academy. In England they knew well enough what it is to wait for results; but he might be believed when he said that the destinies of science on this coast are great, and a time will come that will show great results, and that will come with immense force, and for these two reasons: There is here a most intelligent and most active and progressive population, and, in the second place, there is here one of the most remarkable assemblages of natural objects and physical phenomena that any part of the world possesses. In speaking thus, he included the whole coast north and south of California. There is no section of the earth in which so many singular phenomena can be observed as in this. Without seeking to give advice, he might point out what has been the element of success in the greatest Academy of England, the Royal Society. It began with very few men, and for the best part of two centuries it was supported by what he might, without disrespect to his ancestors in science, call elderly people. It was by the elderly men who loved science, holding together congenially year after year, and almost century after century, that the young men of the society were drawn to it, and it is but lately that young men in any numbers have come into the society. For success there are three principal elements, — the holding together of the elderly members, of those who have had experience of this life in other matters than science, and who bring that experience together, with methodized common sense, of which science consists, to bear upon the objects of the society itself. In the second place, there is the important work of the secretary, together with

that of the publication committee, which should carefully pass judgment upon the communications to be given to the world. The supervision of the papers of a society by several members is perhaps the most important scientific work that any society can perform. Thirdly, there is the necessity of looking well after the funds, and managing them with economy and prudence.

Dr. Gray said it was almost forty years since Sir Joseph and himself spent some few hours together in the neighborhood of London, at the table of a then very venerable man, long since gone to his rest, Archibald Menzies, who was surgeon and naturalist of Vancouver's voyage. The interest in the venerable gentleman arose from the fact that he had been round the globe, and particularly had visited this part of it, and he was the first English naturalist, and almost the first naturalist, who set foot on this part of the continent. Partly through Professor Davidson's investigations he had been enabled to trace the footsteps of Menzies, whose name is merged in so many of our plants, the Madrona for instance. He had found that he had been in San Francisco, at the Presidio, and that he found his way as far as Santa Clara or San Jose, and it is very well known that he visited the point which was then the oldest settlement; that he landed and botanized at Monterey. It was with peculiar pleasure that they had followed in his footsteps at Monterey, and had been able to gather some plants and to see the withered remains of others that he first made known to the civilized world. Monterey is also the spot that some earlier naturalists visited, where the Spanish naturalists Mocino and Lesse collected plants, and also the Russian naturalists, Chamisso and Eschscholtz, whose names are familiar in all our gardens — household names in plants. The season of their visit to the coast had proved unpropitious on account of the great drouth, and what is still worse, from the ravages of the great flocks of sheep which have devastated the herbaceous vegetation of the Sierra. Fortunately the forests remain, the most important vegetation in respect to climate, geographical distribution, and utility. They had been very busy, and their work had not been in vain. They would be enabled to make some interesting comparisons, after visiting the Rocky Mountain region, and to settle, from observation in the field, some of the questions they had sought to settle in the laboratory and the conservatory. In conclusion, he referred to his visit five years ago, and the great pleasure it had given him to have as a companion his old friend Joseph Hooker.

Professor Hayden, in responding to the welcome, indicated the features of the geological survey in progress under his direction, and said he had long desired to make some comparison between the Sierra Nevada Mountains and the Rocky Mountains. It had always been his belief, although the belief had been corrected by his studies of the eastern slope, that there is a general geographical as well as geological unity in all the different ranges of mountains that compose our country. Some geologists have endeavored to give to the Sierra the name of the Cordilleras,

as a generic term, extending it to the Andes and to the eastern range, the Rocky Mountains. Other geologists have sought to make the Rocky Mountains the generic name, including in that range all the rest, and making the Sierra Nevada a branch. He was now inclined to think there is difference enough in the two ranges to regard them as separate, and perhaps almost independent ranges. One object of his visit was to examine the Yosemite Valley, and study the phenomena of its formation, and this he had been enabled to do. At some time he hoped to be in a position to study the geology of the coast carefully.

Professor Davidson added some remarks on the climatology of the coast with reference to ocean currents, and thereafter the Academy adjourned.

— The Princeton College student-expedition to the Rocky Mountains appeared to meet with good success. It started June 21st, and returned early in August, having accomplished a good deal in exploring the botany, zoölogy, palæontology, mineralogy, and topography of Colorado and the region about Fort Bridger in Wyoming. Nearly a thousand species of plants were collected. Of zoölogical specimens there were secured the heads of mountain sheep, elk, deer, antelope, bear, beaver, mountain lion, lynx, wild-cat, badger, etc., with complete skeletons of many animals of lesser size. A goodly collection of fossils was obtained in Colorado and in the Uintah Mountains.

— We have received Monographs of North American Rodentia, by Elliott Coues and Joel Araph Allen. Published as one of the quarto series of the United States Geological Survey of the Territories, F. V. Hayden in charge. Washington, 1877. It contains eleven monographs, five by Dr. Coues and six by Mr. Allen, with appendix; A Synoptical List of the Fossil Rodentia of North America, by J. A. Allen, and Appendix B.; Material for a Bibliography of North American Mammals, by Theodore Gill and Elliott Coues. The volume is carefully indexed, comprises 1091 pages, and contains fine plates illustrative of the skulls of the Muridæ. It may be truly said to be a monumental work upon a single order of mammals.

— One of the most valuable and useful works on zoölogy ever published and which is still passing through the press, is Bronn's Klassen und Ordnungen des Thier-reichs. Of the fifth volume, *Arthropoda*, Lieferung 24 has been the last published. The volume so far as it goes is accompanied by thirty-nine plates, and the text has been prepared by Professor Gerstaecker, the well known entomologist.

— A second edition of the Index Geological Map of Newfoundland, on the scale of twenty-five miles to an inch, has been published by Mr. Murray, whose report for 1876 has been issued.

— The Norwegian Expedition to the North Sea has met with fair success, especially in mapping the sea bottom off the coast of Norway, and ascertaining the limits of the extended barrier which keeps back the cold water coming from the depths of the Polar Sea.

— Sets of recent collections made by Dr. E. Palmer in Northern Arizona and Southeastern California in 1876, and Southern Utah and Nevada in 1877, may be obtained by application to Dr. C. C. Parry, Davenport, Iowa, or Professor Sereno Watson, Cambridge, Massachusetts. The sets number from three hundred to five hundred species, to be sold at $8.00 per hundred species.

— Professor Frederick Wahlgren, of the University of Lund, died in July, aged fifty-seven. Professor T. A. Conrad, the conchologist and palæontologist, died August 9th, aged seventy-four.

PROCEEDINGS OF SOCIETIES.

Boston Society of Natural History. — October 3. Mr. M. E. Wadsworth remarked on the so called tremolite of Newbury, Mass. Dr. T. M. Brewer read some notes on the stilt sandpiper, and Mr. S. H. Scudder exhibited a large collection of fossil insects from Colorado, made during the past summer, under the auspices of Hayden's U. S. Geological Survey of the Territories.

New York Academy of Sciences. — October 1. Mr. G. N. Lawrence presented descriptions of new West Indian birds, and Professor H. L. Fairchild made a communication on the structure of Lepidodendron and Sigillaria.

Appalachian Mountain Club. — October 10. Mr. S. H. Scudder described an ascent of the Sierra Blanca in Colorado.

SCIENTIFIC SERIALS.[1]

American Journal of Science and Arts. — On the Relations of the Geology of Vermont to that of Berkshire, by J. D. Dana. A Preliminary Catalogue of the Reptiles, Fishes, and Leptocardians of the Bermudas, with Descriptions of Four Species of Fishes believed to be New, by G. B. Goode.

Canadian Entomologist. — July. Remarks upon the Cynipidæ, by H. F. Bassett. August. — On the Preparatory Stages of Satyrus nephele, by W. H. Edwards.

Annals and Magazine of Natural History. — The Post-Tertiary Fossils procured in the late Arctic Expedition; with Notes on some of the Recent or Living Mollusca from the same Expedition, by J. G. Jeffreys.

The Geological Magazine. — September. Across Europe and Asia. Part III. The Middle Urals, by John Milne. Geology of the Isle of Man, by H. H. Howarth.

[1] The articles enumerated under this head will be for the most part selected.

Archiv fur Naturgeschichte, Jahrgang 43, Heft 2. — Untersuchungen über den Kaumagen der Orthopteren, von K. F. Wilde. Grundzüge zur Systematik der Milben, von P. Kramer.

The Geographical Magazine. — October. The Seat of War (with a map of the seat of war in European Turkey, by Keith Johnston). M. Dupuis' Explorations in Tongkin and Yunnan. Delta of the Yangtsze River in China, by S. Mossman. A Description of the Island of Formosa, with some Remarks on its Past History, its Present Condition, and its Future Prospects, by J. Morrison. The Crozet Islands (South Indian Ocean), by L. Brine.

The Monthly Microscopical Journal. — October. New Diatoms from Honduras. Described by A. Grunow. With Notes by F. Kitton. Some Additional Remarks on the Measurement of the Angle of Aperture of Object Glasses, by F. H. Wenham.

Quarterly Journal of Microscopical Science. — October. The Doctrine of Contagium Vivum and its Application to Medicine, by W. Roberts. Résumé of Recent Contributions to our Knowledge of Fresh-Water Rhizopoda, Part IV. Rhizopoda Monothalamia Monostomata, compiled by W. Archer. Loxosoma, by Carl Vogt. On the Minute Structural Relations of the Red Blood Corpuscles, by A. Boettcher. Contribution to the Minute Anatomy of the Epidermis in Smallpox of Sheep, by E. Klein. Notes on the Embryology and Classification of the Animal Kingdom, comprising a Revision of Speculations Relative to the Origin and Significance of the Germ Layers, by E. R. Lankester.

The Geological Magazine. — October. Is Man Tertiary? The Antiquity of Man in the Roman Country, etc., by R. D. P. Mantovani. The Antiquity of Man, by J. R. Dakyns. Reversed Faults in Bedded Slates, by E. J. Hebert. The Geology of Sumatra, by M. R. D. M. Verbeek. The Migration of Species, by C. Callaway.

Annals and Magazine of Natural History. — October. Studies on Fossil Sponges, I. Hexactinellida, by K. A. Zittel. On some New and Little Known Spiders from the Arctic Regions, by O. P. Cambridge. On the Changes produced in the Silicious Skeletons of Certain Sponges by the Action of Caustic Potash, by W. J. Sollas. Capture of a Right Whale in the Mediterranean, by A. Doran. Notes on the Pearly Nautilus, by G. Bennett. On a New Insect Pest at Madeira, by T. V. Wollaston. Remarks on Professor E. Haeckel's Observations on *Wyville-thompsonia Wallichii* and *Squamulina scopula*, by H. J. Carter.

Popular Science Review. — October. The Volcanoes of the Haute Loire and the Ardêche, by W. S. Symonds. Flint Implements, by C. C. King. The Song of the Cicada, by J. C. Galton. Caves and their Occupants, illustrated by the Bone Caves of Creswell Crags, by J. M. Mello. Meteorites and the Origin of Life, by W. Flight.